MATHEMATICS EFFICACY AND ITS RELATIONSHIP TO ELEMENTARY TEACHER DEMOGRAPHICS

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NATE MILEY

DR. SERENA SALLOUM - ADVISOR

BALL STATE UNIVERSITY

MUNCIE, INDIANA

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CHAPTER 1: INTRODUCTION

It is difficult to discuss education without raising the issue of student achievement. TIMSS (Trends in International Mathematics and Science Studies) mathematics data over time have shown that students' mathematics achievement in the United States is lagging and has continued to fall behind their peers in select Asian and European countries, such as Singapore, Japan, Finland, and England (TIMSS, 2011; TIMSS, 2015). Likewise, TIMSS data illuminates large discrepancies in American mathematics achievement from students in differing states (TIMSS, 2011). These gaps in the average mathematics achievement of students are not limited to states, but are also present across gender, race, and socioeconomic status. If the building of mathematics instruction upon state standards aligns with federal mandates, what do the existence of gender, ethnicity, socioeconomic status, and regional mathematic achievement discrepancies signify? Many studies with a myriad of perspectives have investigated the issue of student achievement focusing on the relationship between student and teacher. The majority of studies have come to the same conclusion: teachers are an important factor in the development of learning and student achievement (Battista, 1994; Boaler & Staples, 2008; Boonen, Van Damme & Onghena, 2014; Carney, Brendefur, Thiede, Hughes & Sutton, 2016; Palardy & Rumberger, 2008), yet what is still unclear are teacher attributes that are associated with higher levels of student achievement. Specifically, there is a gap in the literature regarding the characteristics of educators that influence elementary teacher mathematics efficacy (Nurlu, 2017; Snyder & Dillow, 2011). For the purpose of this study mathematics efficacy is defined as a person's belief about their general or specific abilities to work with mathematics concepts in a variety of settings (Boonen et al., 2014).

Teachers' efficacy is not new to research or the field of education (Aiken, 1976; Bandura, 1986; Brown, 2005; Chang, 2015; Chester & Beaudin, 1996; Clark, DePiper, Frank, Nishio, Campbell, Smith, & Choi, 2012). Research has found practices and attributes positively and negatively influencing student achievement with teacher efficacy repeatedly cited as an important factor affecting this relationship (Bandura, 1997; Boonen, Van Damme & Onghena, 2014; Bouffard-Bouchard, Parent & Larivee, 1991; Jeffrey, Hobson, Conoyer, Miller & Leach, 2018; Ma, 1999; Palardy & Rumberger, 2008; Schoenfeld & Floden, 2014; Tschannen-Moran, Woolfolk Hoy & Hoy, 1998).

Teacher mathematics efficacy is an important concept correlated to student learning (Chester & Beaudin, 1996; Fives & Buehl, 2010; Miller, Ramire & Murdock, 2017; Rounds & Hendel, 1980). Many studies of teacher mathematics efficacy use samples of preservice teachers (Betz, 1978; Bleicher & Lindgren, 2005; Cunningham & Blankenship, 1979; Ginns, Tulip, Watters & Lucas, 1995; Hendy, Schorschinsky & Wade, 2014; Miller et al., 2017), but few utilize practicing teachers. There is a gap in the body of research focusing on teacher attributes related to higher levels of mathematics efficacy in practicing elementary teachers. In this dissertation, I deepen the understanding of the teacher attributes related to higher levels of mathematics efficacy in elementary teachers. The following is a summation of the research and thought that has developed the understanding of mathematics instruction, teacher efficacy, teacher mathematics efficacy, and any known relationships that these topics have to one another.

Achievement Gaps

In order to better understand how elementary teacher mathematics efficacy relates to student achievement, it is important to understand mathematics achievement at the local,[1] state,

[1] Local level results will be from a large, diverse, and urban district in TN and be discussed in Chapter 4.

and national level. According to recent TIMSS data (TIMSS, 2015) there is much room for improvement in mathematics achievement nationwide. Though TIMSS recently released data from its 2015 tests, this release of information focuses more on countries and the global perspective than the individual states within the United States. The data from 2011 were fully available at the time of this writing and is the best reference point to illustrate achievement patterns. Table 1 shows student achievement in three states that represent high, middle, and low achievement on TIMSS (2011) mathematics tests for eighth grade students.[2] These three states were chosen because one has the highest student scores nationally (TIMSS, 2011), one is regionally close to where this dissertation research was conducted, and one is within the same geographic region as my sample and has the lowest scores nationally (TIMSS, 2011). Utilizing these three states thereby represents a cross-section of the Midwest, South, and Eastern United States as well as the nation as a whole.

Table 1. *2011 TIMSS Mathematics Achievement 8th Grade Students*

	Average						Poverty	
Achievement	Scores	*Male*	*Female*	*White*	*Black*	*Multi*	*Over 75%*	*10-25%*
High	561	558	563	572	516	567	491	576
Middle	522	526	518	530	467	530	474	551
Low	466	465	467	489	428	492	429	510
United States	539							
TIMSS Scale Average	500							

Table 1 displays a comparison of male versus female students, where male average scores were lower than female average scores except for the middle state. Female students in the high

[2]At the time of this writing the 2015 student and state TIMSS data were embargoed and limited to very few important details to this work. I chose to focus on eighth grade data because fourth grade data only contained breakdowns of Florida and North Carolina's data, whereas eighth grade had a wide array of state data to disaggregate. Eighth grade data is pertinent to this study because these students are only three to four years removed from elementary school and still have spent the majority of their educational mathematics experience within the elementary setting.

and middle states scored above the TIMSS average score and male students in the high and low states scored below the state average score. Males in the low state scored below the state, national, and world averages.

In Table 1, notice white students were among the top scorers across all demographics—outperforming state, and sometimes national, and world averages. It is interesting to note black students' average scores were far below their state median scores by 38 points or more, yet black students in the high state still outscored all demographics in the low state. Multiracial students in the high, middle, and low states scored higher than their home state averages. Also important is multiracial student scores mirrored overall student achievement in the high and middle states with multiracial students in the high state scoring well above state/national averages and multiracial students in the middle state scoring close to state/national averages. Multiracial students in the low state scored above the state average, yet well below the national average.

For impoverished students, as measured by receipt of free and reduced priced lunch, the focal states had similar results. Schools with 75% or more poverty scored below their home state averages, as well as the national and world averages. It is noteworthy that the high and middle impoverished students had a higher average than black students in the low and middle states and all demographics in the low state excluding white and multiracial students. Schools with 10-25% poverty had much higher average scores than their home state averages as well as world averages. As a subset in the low state, these students, though greatly outscoring their peers in the state, were below the state average scores of both the middle and high states. As these results were reported by mean percentages, they could be demonstrative of a national educational system where students attending the best schools in the low state are still performing worse in mathematics than the average student in the middle and high states.

Teacher Mathematics Efficacy

The data in Table 1 help illustrate two potential problems with mathematics instruction nationally. First, mathematics outcomes vary widely by region and student demographic category. Second, on average, student mathematics outcomes in the United States are lower compared to student outcomes in Singapore, Finland, Japan, and England (TIMSS, 2015).

These data are indicative of investigations in mathematics curriculum and instruction within the United States. Research illustrates there is a national problem pertaining to mathematics education within the elementary school setting. Elementary schools are hiring teachers whom are technically qualified and trained to work with young students. However, these same teachers may harbor feelings of uneasiness or insecurity in relationship to teaching mathematics (Boonen et al., 2014; Boston, 2012; Brown, 2005; Chavez & Widmer, 1982; Cobb & Jackson, 2011; Hall, 1992; Hendy, Schorschinsky & Wade, 2014; Hembree, 1990; Hoy & Spero, 2006; Jeffrey et al., 2018; Kelly & Tomhave, 1985; McAnallen, 2010; Miller et al., 2018; Palardy & Rumberger, 2008; Swars, Daane & Giesen, 2006). This is happening because the qualifications for working with young students tend to center around classroom management, pedagogy, and practice (Marzano, Marzano & Pickering, 2003). Rarely do college programs have the time and resources to focus on reversing, developing, or addressing pre-service teacher mathematics efficacy (Brush, 1980; Chavez & Widmer, 1982; Cunningham & Blankenship, 1979; Hendy et al., 2014; Jeffrey et al., 2018).

Statement of Problem

Research has shown teacher efficacy to be associated with student achievement. Students develop their foundational mathematical skills under the influence of elementary teachers. Therefore, there is a need to understand teacher efficacy in mathematics due to gaps in student achievement. This problem has especially influenced elementary students negatively in terms of their mathematics achievement because of the link between self-efficacy[3] and teacher action (Chang, 2015; Boonen et al., 2014; Boston, 2012; Brown, 2005; McAnallen, 2010), however what not fully understood are the teacher attributes associated with higher levels of mathematics efficacy in elementary teachers. At present, it is unclear if the Teacher Sense of Efficacy Scale (TSES) translates to mathematics efficacy and the extent to difference in teacher demographics (such as mathematics efficacy, race, gender, experience, and teacher training) (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998).

Purpose of Study

The purpose of this study was to adapt the TSES to explore what teacher attributes relate to higher levels of mathematics efficacy in practicing elementary teachers. The dependent variables were mathematics efficacy scores of elementary teachers as measured by the TSES and the three subscale (Student Engagement, Instructional Strategies, and Classroom Management) mathematics efficacy scores on the TSES. The independent variables were teacher gender, experience, highest level of degree attained, race, grade level, and highest mathematics class taken in college.

Research Questions

The central research questions guiding this study include:

1. How does the Teacher Sense of Efficacy Scale (TSES) adapt and serve as a reliable measure of mathematics efficacy?

[3] Self-efficacy will be referred to as teacher efficacy for the duration of this study after the Development of Efficacy section in Chapter 2.

2. How does elementary teacher mathematics efficacy (as measured by the adapted TSES) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?
3. How do the subscales of the adapted TSES (Student Engagement, Instructional Strategies, and Classroom Management) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?

Significance of Study

The study of efficacy is not new to the greater body of research (Bandura, 1977; Rotter, 1966), nor is the study of teacher efficacy (see for example, Brown, 2005; Jeffrey et al., 2018; Hendy et al., 2014; Hall, 1992; Hoy & Spero, 2006; Palardy & Rumberger, 2008; Schoenberger & Russell, 1998; Tschannen-Moran et al., 1998). However, this study will add to the scholarly research in those fields by being one of the only studies to show how the TSES can be adapted to study the influence of teacher mathematics efficacy in the elementary setting (Ma, 1999; Swars et al., 2006). The bulk of the existing research focuses on upper level mathematics classes, mathematics related fields, and preservice teacher training courses. In contrast, this study attempts to understand what teacher attributes relate to higher levels of mathematics efficacy in practicing elementary teachers.

This study can inform schools by assisting preservice elementary teacher training programs in understanding the importance of addressing low mathematics efficacy prior to graduation (Jeffrey et al., 2018; Miller et al., 2017; Swetman, 1994), and by assisting elementary principals in understanding the importance of onboarding practices for new hires and professional development of existing staff to increase mastery experiences and address elementary teacher mathematics efficacy (Carney et al., 2016; Hembree, 1990, Nurlu, 2017). Furthermore, this study can assist teachers in better understanding factors within their control that influence mathematics efficacy (Brown, 2005; Chang, 2015).

Limitations of the Study

The data collection for this study were limited to elementary school teachers (kindergarten through fourth grade) in a sample of elementary schools within a large urban school district. The sample did not include teachers in rural or suburban environments, which limits the generalizations about mathematics efficacy.

Definition of Terms

In this section, I will provide terms used in this dissertation.

- *Curriculum* - The content that comprises a teacher's lesson (Battista, 1994).
- *Instruction* - The methods used by a teacher to make curriculum accessible to students (Borko, 2004).
- *Efficacy* or *Self-efficacy* - A person's belief in his or her own abilities to directly influence change in another (Bandura 1977, 1994, 1997).
- *Mathematics anxiety* – "The panic, helplessness, paralysis, and mental disorganization that arises among some people when required to solve a mathematics problem" (Hunt, 1985, p. 32).
- *Mathematics efficacy* - A person's belief about their general or specific abilities to work with mathematical concepts in a variety of settings (Boonen et al., 2014).
- *Teachers' Sense of Efficacy Scale* or *TSES* - A Likert-scale efficacy measurement tool (Tschannen-Moran & Woolfolk Hoy, 2001).

- *Teacher Efficacy* - An educator's belief about their ability to effectively pass on information to their students (Bandura, 1977).

Organization of Study

This study is divided into five chapters, a list of references, and appendices in the following manner. Chapter 2 will discuss the literature surrounding mathematics efficacy and its study within classrooms as well as any correlations with student achievement. Chapter 3 will expound on my research design and methods. I will describe my sample, instrumentation, procedures for data collection, and introduce the process to analyze the data gathered. Chapter 4 will include findings from this study. Chapter 5 will be major findings, limitations, and implications for future research. Following this are references and appendices containing relevant documents to this research study.

Summary

This study will explore what teacher attributes relate to higher levels of mathematics efficacy as measured by the adapted TSES survey. It will broaden the understanding of how the adapted TSES survey can assist educational leaders in knowing the influence of mathematics efficacy as shaped by teacher demographics, as well as understand patterns of mathematics efficacy in grade levels. As efficacy is a broad topic with multiple ways of influencing a classroom, Chapter 2 provides a comprehensive literature review, providing more detail about the development of modern understanding of mathematics efficacy, factors affecting teacher mathematics efficacy, and research on student achievement.

CHAPTER 2: REVIEW OF THE LITERATURE

In this chapter, I explore literature related to teacher mathematics efficacy. First, I review the development of efficacy as a concept through Albert Bandura's work, including the various components that contribute to the contemporary understanding of what efficacy is and the influence it has on action. Second, I review the enactment of mathematics in elementary classrooms; I discuss practices documented in mathematics education associated with student achievement in mathematics. Third, I review various models of measuring efficacy and mathematics beliefs. Fourth, I review mathematics efficacy. I discuss how Bandura's work on efficacy and practices in mathematics instruction can affect teacher mathematics efficacy and student mathematics achievement. Fifth, I review different perspectives on the influence mathematics efficacy has on student achievement and teacher behavior. Finally, I summarize the literature and segue into the methods for my research.

Development of Self-Efficacy Beliefs

This section will describe the development of self-efficacy beliefs by outlining some of the research that contributed to the work of Bandura as well as defining what self-efficacy is. It begins with Rotter's Locus of Control model and ends with a description of the major sources of self-efficacy its association with student achievement.

When teacher behavioral patterns do not coincide with evidence-based action, researchers and school leaders must look deeper into the motivations that are driving those behaviors. One such motivation is low mathematics self-efficacy. To understand how teacher mathematics efficacy could contribute to teacher action, it is critical to begin with understanding social cognitive theory.

The 1960s were a time of newfound freedom for some and cultural unrest for many. American norms began to come under scrutiny through cultural shifts such as the rise of feminism and America's space race. The country began to wrestle with the possibilities of women filling positions of power instead of traditional roles of homemakers and teachers, while at the same time the Soviet Union's mathematics and science achievements culminated in a showing of space dominance. These cultural and national events began to create doubts amongst the American public about the quality of education occurring in classrooms (Ravitch, 2000). These doubts led politicians to question the adequacy of teacher training programs in mathematics and science (Ravitch, 2010). This national dialogue produced public demand for more rigorous instruction within American schools. This public scrutiny led teachers to begin to be uncomfortable with the increasingly technical aspects of teaching mathematics and science (Victor, 1962).

Locus of Control

Victor (1962) was one of the first researchers to survey elementary teachers about their comfort in relation to science curriculum. He concluded elementary teachers were concerned about teaching a subject where they were not confident in their own abilities and/or understanding of the material. The implication of his work was the understanding that elementary teachers in the 1960s were shying away from teaching elementary science because they were not confident with their own understanding of the topic of science, not necessarily the age-appropriate science curriculum they were required to teach (Bleicher & Lindgren, 2005).

Later research furthered Victor's understanding of confidence and became the target of Rotter's (1966) groundbreaking study where he developed Victor's work on confidence into his own, *Locus of Control* (LOC) model. Rotter's research designated two distinct LOCs and defined them as; internal LOC, the confidence one has in his/her own abilities; and external LOC, the attribution to fate or the notion that the outcomes of a situation are altogether out of the individual's control (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998). The results of Rotter's study confirmed that a person's beliefs about the environment of a situation, or the factors contributing to the situation, could have a greater influence on behavior than truth or fact-based information (Bandura, 1977). For example, if a dog attacks a child at an early age, the child may develop a fear of dogs as he grows into adulthood. During that time, he may witness dogs interacting appropriately with children and even form relationships with others who have dogs, yet his thinking towards dogs could continue to focus on dogs being mean or dangerous animals.

In essence, Rotter studied the power of a person's beliefs to shape his or her reality and his or her reactions within the confines of those beliefs even when confronted with conflicting information. What Rotter proposed to the educational community at large was groundbreaking at the time as it showed how a person with high confidence would have a strong internal LOC and weak external LOC, and the inverse relationship was true of someone with low confidence having a weak internal LOC and strong external LOC (Rotter, 1966).

Self-Efficacy

The LOC model is one of two important ideas necessary to understand efficacy. Psychologist Albert Bandura (1977), through his social cognitive theory, developed the second idea. Bandura merged the research from Victor's confidence hypothesis and Rotter's LOC model by directly linking results or effects to a person's beliefs in conjunction with their actions (Tschannen-Moran et al., 1998). Prior to Bandura's work there were many social theories and theorists working towards understanding what is now called social cognitive theory and his construct of self-efficacy, yet Bandura's theory as espoused in his 1977 book *Social Learning*

Theory, was where much of this existing research was combined and studied for the first time as a collective body of work. This broadened the scope of understanding about the importance of efficacy in relation to all areas of psychology and therefore needed clarifying terms for this new discovery.

Bandura (1994) defined *efficacy* as a person's belief in his or her own abilities to directly influence change in another. A second important idea, *efficacy expectations* (Bandura, 1977, p. 193), builds upon Rotter's work by uniting his separate ideas of the internal and external LOC into one framework of action that incorporates intrinsic and extrinsic factors. Efficacy expectations are the personal belief in one's ability to complete a task (Tschannen-Moran et al., 1998). A third idea developed from Bandura's research, was *outcome expectations* (Bandura, 1977, p. 193). Outcome expectations are the beliefs that doing X will directly contribute to the accomplishment of Y. It is important to note that outcome expectation is different from efficacy expectation in that outcome expectation is a person's belief in their ability to complete a task at a specific level instead of a generic feeling of competency (Bandura, 1986). For example, efficacy expectation describes how I feel about my performance on a general mathematics test. In contrast, outcome expectancy describes how I feel about my performance on an algebra test, or pre-calculus test, or how well I can apply algebraic concepts in the classroom, in my home project, or in a business presentation. Efficacy expectation is more of a broad can or cannot, good or bad litmus test, while outcome expectancy can run a range of competency depending on the rigor of the perceived task. Researchers Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) described this difference as,

> The efficacy question is, 'Do I have the ability to organize and execute the actions necessary to accomplish a specific task at a desired level?' The outcome question is, 'If I accomplish the task at that level, what are the likely consequences?' (p. 210)

Stated differently, if a teacher has low mathematics efficacy then the outcome expectation would be not believing that students in the classroom could learn mathematics.

Bandura's (1982) study unified the behavioral beliefs under his classification of *self-efficacy* as a cognitive function where one develops beliefs about how effective one can be at a specific level of performance while undergoing a specific task. He defined *self-efficacy* as, "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Self-efficacy can be understood as a future-based assessment of one's abilities that shape one's thought patterns and emotions (Bandura, 1996). The major sources affecting self-efficacy identified by Bandura (1986) were *mastery experience*, *physiological arousal*, *vicarious experience*, and *verbal persuasion*.

Mastery experience. Mastery experiences are the most influential source on a teacher's self-efficacy both positively and negatively. It is important to understand that mastery experiences are not descriptions of performance; rather they are a description of the perception of performance. Thus, the perception that a performance has been successful raises self-efficacy and the inverse is also true. This is an important part of understanding mastery experiences because a successful or failing performance does not always lead to higher or lower self-efficacy. When there are large amounts of external help, when the mastery experiences occur late in learning, or when the task is easy to begin with, the successful performance will not increase self-efficacy (Tschannen-Moran et al., 1998). For example, if a teacher had a successful fifth year in the classroom that involved heavy amounts of outside support from an administrator, coach, and other teachers, she may attribute her success to the help of others and/or feel as if she should be able to control her classroom without external supports that late in her career. Both of these thoughts could contribute to lower self-efficacy in teaching.

Physiological arousal. Physiological arousal describes the emotions associated with performing a task (Bandura, 1997). For example, the feeling of butterflies or jitters is a physiological response to thinking about or anticipating an upcoming performance, such as the first day of school. Physiological arousal is accompanied by a physical response, such as sweaty palms or increased heart rate, which can become associated with being nervous, excited, etc. This bodily response connects with the outcome of the performance, and if attended to, can contribute to higher or lower efficacy by focusing one's attention on the performance or impairing one's ability to perform (Tschannen-Moran et al., 1998).

Vicarious experience. Vicarious experiences are associations built through experience. Vicarious experiences could be exposure to student teaching, a highly efficacious mathematics teacher, or even pop culture teacher stereotypes because they contribute to the development of comparisons. These comparisons become bridges to explanations of performance. For example, watching a poorly executed lesson may lead a teacher to believe that the students cannot learn, that the lesson was poor due to a poor teacher, and/or lead the viewer to believe they are a much superior teacher and could do a better job of guiding instruction (Nurlu, 2015; Tschannen-Moran et al., 1998).

Verbal persuasion. Verbal persuasion refers to conversations such as feedback during a post-conference, a professional development seminar, or working with a coach. These experiences can equip a teacher with the necessary tools to implement better instruction, or they may leave them feeling inadequate to the task. Directly tied to the effect of verbal persuasion is the credibility of the giver (Tschannen-Moran et al., 1998). For example, students who feel their teacher is incompetent are less likely to believe the strategy taught on a given day is the best way to solve a problem.

Integrated Model of Teacher Efficacy

The Integrated Model of Teacher Efficacy (Tschannen-Moran et al., 1998) can help in understanding elementary teacher trepidation towards mathematics. Figure 1 shows this model and how it incorporates these sources of self-efficacy to show the interrelated nature of the sources of efficacy and their influence on teacher performance. The previously discussed sources of efficacy are all channeled into and interpreted by one's cognitive processing. Without this processing, the sources of efficacy are not likely to have a significant influence on behavior because those sources lead the teacher to analyze what the performance task is in relation to the classroom and their level of skill in completing it. This is the process for the development of a teacher's self-efficacy in relation to specific situations and subject matter. The teacher's self-efficacy then influences the amount of energy, time, and effort put forth, which becomes the performance. The cyclical nature of efficacy comes after the performance as one has a mastery experience, physiological arousal, and new vicarious experience to process, which starts the cycle afresh either contributing to higher, lower, or null effects on self-efficacy. For example, a second-year elementary teacher identifies himself as having low mathematics efficacy because he is not good at mathematics. This feeling is rooted in experiences of getting poor grades in mathematics classes, conversations with peers in mathematics related fields, and teaching mathematics experiences during his first year as an educator. All these sources are processed and aligned to his experiences as a first-year teacher. He was uncomfortable teaching mathematics to his students despite his mastery of basic addition facts because he was nervous a student would challenge him during a lesson or an administrator would come and deliver negative feedback. He planned mathematics with his teammates, but the confidence of his fellow teachers made him perceive his lack of confidence to theirs as further sign of his inabilities in the subject. All this led to his belief that he was neither good at mathematics nor teaching it to his students. The consequence of this belief was more time planning and preparing for subjects other than mathematics. This minimal planning of mathematics led to mediocre lessons that helped students remember the material short term, but did not expose them to mastery experiences, created negative vicarious experiences, and a lack of verbal persuasion from teacher to students. These new sources of information during his summer reflection add to his already pre-existing ideas and sources of efficacy, which reinforce his low mathematics self-efficacy and start the cycle over again.

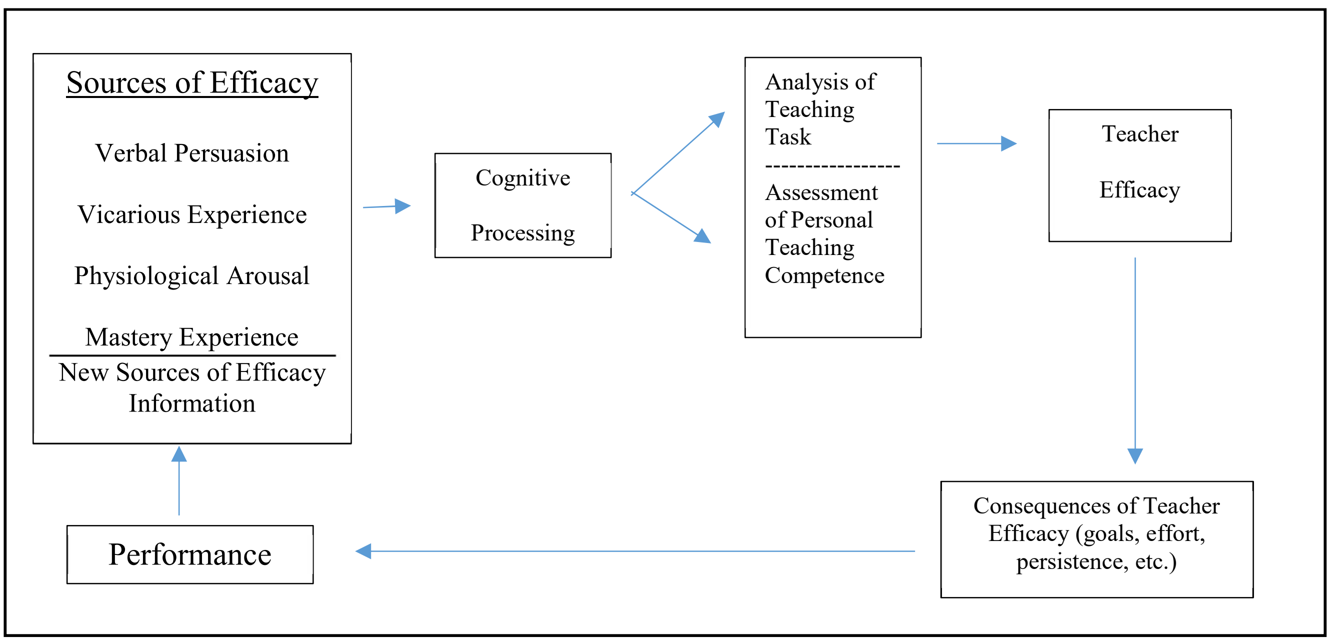

Figure 1. Integrated Model of Teacher Efficacy

It is important to understand that self-efficacy is different from self-esteem because efficacy is wedded to a particular task, whereas self-esteem is self-evaluation, such as self-worth.

Saying, “I am able to complete this task” is a measure of self-efficacy, whereas “I don’t feel like I am good enough to do this well” is a measure of self-esteem (Bandura, 1997). Efficacy, then, lacks the imbedded evaluative nature comprised in self-esteem. A person can exhibit low levels of efficacy towards a task, such as teaching mathematics, but it does not necessarily affect their self-esteem (Tschannen-Moran et al., 1998).

It is important to note how Rotter’s (1966) Locus of Control and Bandura’s (1977) self-efficacy are different, yet both contribute to fully understanding efficacy. Locus of Control (LOC) refers to the ability of a teacher to control the influence of their actions on their environment, their students individually and collectively as a whole classroom, yet this understanding does not define who controls the environment in a classroom, the teacher or the students (Goddard, Hoy & Hoy, 2000). Self-efficacy is much more quantifiable as it is someone’s belief in his or her ability to execute at a specific level of performance. This is why efficacy is a much stronger predictor of action than Rotter’s LOC.

Self-efficacy appears confined to perceived levels of skill rather than the actual measure of that skill. Human nature is to over-or under-estimate skill levels (Bandura, 1997), which has been shown to influence decisions made and actual performance (Boonen, Van Damme & Onghena, 2014; Boston, 2012; Brown, 2005; Chang, 2015; Chavez & Widmer, 1982; Cobb & Jackson, 2011; Hall, 1992; Hendy, Schorschinsky & Wade, 2014; Hembree, 1990; Hoy & Spero, 2006; Kelly & Tomhave, 1985; McAnallen, 2010; Nurlu, 2015; Palardy & Rumberger, 2008; Swars et al., 2006). Bouffard-Bouchard, Parent, and Larivee (1991) used an experimental task with 90 junior high and high school students and found that efficacy beliefs influenced mathematics achievement in both junior high and high school students who had the same skill level in solving mathematics problems. Students who had higher mathematics efficacy were more likely to effectively apply their knowledge/skills, be more persistent, and not reject correct solutions prematurely, as compared to their counterparts (Chang, 2015).

It is important to note that efficacy in education is complicated because the implementation of instruction requires teachers throughout each lesson of the day to make a myriad of decisions, overcome challenges, and assess performance levels required for each task and individual student. Day to day, lesson-to-lesson, and even amid meeting with different small groups of children in the same classroom, a teacher's level of efficacy may change (Ross, 1994). As Tschannen-Moran and colleagues (1998) found,

> . . . teachers do not feel equally efficacious for all teaching situations. Teacher efficacy is context specific. Teachers feel efficacious for teaching particular subjects to certain students in specific settings, and they can be expected to feel more or less efficacious under different circumstances. (p. 482)

Teacher Efficacy and Student Achievement

In measuring the relationship between teacher efficacy and student achievement, it is important to take into consideration the many teacher demographics that could influence efficacy and thereby instruction. Klassen and Chiu (2010) understood this when studying the relationships between efficacy and years of experience, gender, and teaching level. Their sample of over 1,400 practicing teachers used the TSES to find years of experience not linearly related to efficacy in incorporating teaching strategies and student engagement. As teachers began their careers, their general teaching efficacy in those two areas steadily grew until year 23 in the profession and then began declining until teachers quit or retired. They also noted male teachers reported lower levels of stress and higher levels of job satisfaction than female teachers did. This may be due to different demands on teachers at the different grade levels taught, yet other research has suggested a connection between teacher race and cultural beliefs (Klassen, Bong, Usher, Chong, Huan, Wong & Georgiou, 2009).

Wolters and Daugherty (2007) likewise used the TSES with over 1,000 practicing teachers from prekindergarten through twelfth grade to measure the effects of experience on efficacy in implementing instructional strategies and student engagement. Their research found years of experience to have a modest influence on efficacy ($F = 13.04$, $p = .04$). Elementary teachers reported having higher efficacy in student engagement than other instructional tiers. It should be noted their research only had four categories for quantifying years of experience with the last being 11 years or more, which would not account for the variability of efficacy responses occurring within more experienced teachers.

McAnallen (2010) studied the development of mathematics anxiety in 691 teachers across eight states in urban, rural, and suburban communities. Mathematics anxiety is the panic, helplessness, paralysis, and mental disorganization that arises among some people when required to solve a mathematics problem (Hunt, 1985, p. 32). The presence of mathematics anxiety can be a factor in one's level of mathematics efficacy, especially in teachers (Hendy, Schorschinsky & Wade, 2014). Most teacher participants reported the highest mathematics class taken in undergraduate studies as a remedial mathematics class, and 26% of participants reported an initial negative experience with mathematics occurring in the elementary school setting.

Jeffrey, Hobson, Conoyer, Miller, and Leach (2018) researched the development of mathematics efficacy in junior and senior students in elementary education programs across five universities. Their study included 75 participants equally split between indicating positive efficacy reactions to teaching mathematics and negative efficacy reactions. Their conclusions were the lack of mathematics content courses in universities could be contributing low efficacy results in pre-service teachers. They also suggested more classroom experiences prior to graduation as a way to build mastery experiences and higher mathematics efficacy (Miller, Ramire & Murdock, 2017).

Summary

In summation, self-efficacy is dynamic (Bandura, 1986; 1987; 1993). As teachers' thoughts, beliefs, and pre-conceived notions can change, so too can self-efficacy change. It is important to note that the factors that contribute to self-efficacy change can be real or perceived, and regardless the influence on self-efficacy is real and tangible (Tschannen-Moran et al., 1998). For example, a previously successful presentation could raise a person's efficacy beliefs, which in turn would contribute to the expectation of future success.

> Efficacy beliefs help determine how much effort people will expend on an activity, how long they will persevere when confronting obstacles, and how resilient they will prove in the face of adverse situations- the higher the sense of efficacy, the greater the effort, persistence, and resilience (Pajares, 1996, p. 544).

Efficacy's influence on effort, perseverance, and resilience helps illuminate why some teachers may knowingly choose to avoid, abandon prematurely, or erroneously use practices in education, but what is still unclear is how efficacy might contribute to such disparaging gaps in mathematics education across the United States.

Mathematics Instruction

This section will describe how ambitious mathematics instruction and the National Council of Teachers of Mathematics attempt to raise student mathematics achievement. It continues to describe how those recommendations are related to mathematics efficacy and teacher instruction.

While Table 1 helps illustrate the differences between student achievements regionally, it provides little insight into why and how these differences can occur. An important factor contributing to student success in the classroom is the influence of a highly effective teacher (Marzano, Marzano & Pickering, 2003). This is because the highly effective teacher is in control of the instruction that occurs in the classroom. Instruction in this study does not refer to a specific teaching strategy used nor the incorporation of a specific curriculum; rather it is,

> Instruction consists of interactions among teachers and students around content in environments. . .'Interaction' refers to no particular form of discourse but to teachers' and students' connected work, extending through, days, weeks, and months. Instruction evolves as tasks develop and lead to others, as students' engagement and understanding waxes and wanes, and organization changes (Cohen, Raudenbush & Ball, 2003, p. 122).

It is therefore important to understand current teacher mathematics beliefs in elementary schools in order to begin to understand the relationship between student achievement and mathematics efficacy (Carney, Brendefur, Thiede, Hughes & Sutton, 2016; Stevens, Aguirre-Munoz, Harris, Higgins & Liu, 2013).

Ambitious Mathematics Instruction

Ambitious mathematics instruction, a specific and measurable way of interacting with curriculum, positively influences mathematics efficacy in students. When used effectively, it helps both individual students and the classroom as a whole learn mathematics in a way where students are eliciting and learning from the responses from others to increase mathematics efficacy (Kazemi, Franke & Lampert, 2009). This happens through a shift away from exploring problems to discover the correct answer and towards students engaging in problem solving for knowledge building. For this kind of environment and teaching to exist, teachers must be responsive to individual students as well as the classroom as a whole to guide students from teacher dependency toward a willingness to take risks through enabling prompts and language supports (Anthony & Walshaw, 2009; Muis & Duffy, 201; Nurlu, 2017).

By name alone, ambitious mathematics instruction should impart an image of arduous teaching that involves high levels of skill. The challenges involved in ambitious mathematics instruction, as noted by Lampert, Boerst, and Graziani (2011), are many and daunting. First, student exposure to authentic mathematics tasks at the same time as they are developing foundational mathematics skills is critical. Second, teachers must be knowledgeable in an array of methods that students may use to solve problems for ascertaining student competency in the implementation of the solution method (Clark, DePiper, Frank, Nishio, Campbell, Smith & Choi, 2012). Third, teachers must be able to differentiate the rigor of the work to meet the needs of the range of skills within the classroom. Finally, teachers must create and control instruction where students are willing to express their ideas as well as listen to the ideas of others to develop understanding. This was evident in Nurlu's (2015) work; he studied 33 elementary teachers within seven elementary schools in the same district and utilized interview data to identify key differences between teachers with high and low efficacy beliefs. The most important differences as they relate to ambitious mathematics instruction were a willingness to show more effort with students, taking responsibility for students' success, and openness to new methods that might reach all learners.

National Council of Teachers of Mathematics Guidance

The National Council of Teachers of Mathematics (NCTM) publications use national sample sizes, research, and experts in the field to diagnose and prescribe tested and proven interventions (Giordano, 1993; Lesh, Chval, Hollebrands, Konoid, Stephan, Walker & Wanko, 2014; Maccini & Gagcon, 2002; Perrin, 2012; Prichard, 1995). An overview of their research-based techniques to stimulate mathematics achievement include but are not limited to teaching concepts, incorporating games, and creating a dependent classroom atmosphere between students and teacher. NCTM also champions teacher professional development combined with continued support and guidance from administration and experts in order to be successful in raising student achievement (Borko, 2004; Stevens et al., 2013). Borko's (2004) research also added,

> To foster students' conceptual understanding, teachers must have rich and flexible knowledge of the subjects they teach. They must understand the central facts and concepts of the discipline, how these ideas are connected, and the processes used to establish new knowledge and determine the validity of claims (p. 5).

In summary, for elementary teachers to successfully raise student achievement in mathematics they must have high levels of administrative support, well-planned lessons that involve techniques other than lecture and worksheets, and an environment of mutual trust (Carney et al., 2016; Muis & Duffy, 2013). If an elementary teacher is able to foster a classroom environment like that, the next step is to develop a technical understanding of the mathematics concepts they teach, how each individual concept best correlates and builds upon one another, and then implement this knowledge in a way that fosters new learning in young children. This is a lofty expectation for a first-year teacher as well as the experienced veteran who may have entered the profession primarily because he/she enjoyed working with young children (Ma, 1999).

Teachers' Mathematics Efficacy and Instruction

Though these and other initiatives, reforms, and curriculum claim to be a solution to poor student mathematics performance, their efforts to bolster student achievement in mathematics overlook the importance of mathematics efficacy as a component to student success (Clark, DePiper, Frank, Nishio, Campbell, Smith & Choi, 2012; Max & Glazerman, 2014; Minor, Desimone, Spencer & Phillips, 2015). Boonen, Van Damme, and Onghena's recent study of 3,476 first grade students in 196 first grade teachers' classrooms across 111 elementary schools utilized a multilevel regression model to study teacher variables and the effect on student achievement (2014). Their results confirmed the idea that student success in mathematics is rooted in more than just curriculum when noting teacher background, mathematics efficacy, and job satisfaction had a much larger effect on student achievement than instructional practices alone.

As suggested previously, teacher mathematics efficacy will also influence effective implementation of ambitious mathematics instruction even when the teacher incorporates suggested NCTM techniques (Maccini & Gagcon, 2002; Palardy & Rumberger, 2008). The largest factor in student achievement is a highly effective teacher, per Robert Marzano, Jana Marzano, and Debra Pickering (2003) and Hall's (1992) research that found highly effective teachers, as measured by achievement on standardized test scores, also exhibited high levels of teacher efficacy. This study attempts to further the understanding of Marzano, Marzano, Pickering, and Hall's work by understanding the influence various demographics have on teacher mathematics efficacy. Specific to mathematics, the largest factor influencing student achievement is not the how curriculum is taught; rather it is the teacher's mathematics efficacy that has the capacity to change the learning environment of a classroom (Boonen et al., 2014; Muis et al., 2013; Stevens et al., 2013). Likewise, some researchers have suggested teachers with high mathematics efficacy directly contribute to increased student achievement in mathematics (Ma, 1999; Swars et al., 2006).

Not all researchers agree that the NCTM actions are good for teachers and suggest these reforms could be contributing to lowered teacher mathematics efficacy despite many historically focusing on raising teacher mathematics efficacy (Borko, 2004; Brush, 1991; Karp, 1991, Snyder & Dillow, 2011). Teachers may respond to the national atmosphere of increased accountability pressure by reverting to ineffective practices explicitly, per the NCTM, such as incorporating more lecturing, teaching the basic skills, seatwork, whole class instruction, and reading straight from mathematics textbooks (Borko, 2004; Haney, Czerniak & Lumpe, 1996; Karp, 1991). In an elementary setting related to mathematics instruction, teachers exhibiting low mathematics efficacy may wish to avoid teaching mathematics (Wenner, 2001), however the option of directly avoiding mathematics is impossible as it is a required part of daily instruction (Schoenfeld, 2013). As students have no choice participating in high-stakes testing involving mathematics, a plausible escape comes through avoiding the implementation of new ideas, collaborating with peers, and engaging students in meaningful dialogue about mathematics (Muis et al., 2013; Trice & Ogden, 1986), which are the practices the NCTM most encourages in elementary mathematics instruction.

In summary, the answers to increased student achievement in mathematics per the NCTM are many of the same practices likely avoided in classrooms of teachers with low levels of mathematics efficacy (Wenner, 2001). If increased student achievement results through the implementation of specific research-based techniques, why are some elementary teachers avoiding their implementation (Borko, 2004; Max & Glazerman, 2014; Werner, 2001)?

Measurement of Mathematics Efficacy Beliefs and Mathematics Beliefs

This section will describe some different measures of mathematics efficacy as well as a detailed description of the TSES which was utilized for this study.

The influences of mathematics efficacy beliefs and degree of these influences, as discussed previously, vary and come from a myriad of stimuli (Tschannen-Moran et al., 1998). This understanding leads to the need for instrumentation that can identify the presence of positive or negative beliefs and the degree to which those beliefs are influencing decisions within the classroom. Through effective measurement of mathematics efficacy beliefs, researchers began to better understand teacher actions in light of their beliefs and identify a continuum of motivation (Borko, 2004; Zuya, Kwalat & Attah, 2016).

Fennema-Sherman Mathematics Attitudes Scale

The work to understand this continuum fueled the development of instrumentation to measure the influence of mathematics efficacy on teachers and students (Boston, 2012; Enochs, Smith & Huinker, 2000; Fennema & Sherman, 1977; Guskey & Pisaro, 1994; Hoy & Spero, 2006). While many early instruments focused only on measuring teacher mathematics efficacy through the measure of mathematics anxiety, the Fennema-Sherman Mathematics Attitude Scales (FSMAS) was one of the earliest tools designed to measure mathematics anxiety as well as mathematics efficacy of teachers (Fennema & Sherman, 1977). Chavez and Widmer (1982) utilized the FSMAS and found 16% of their sample of experienced elementary teachers scored in the mathematically anxious category. Within their sample, 20 of the identified teachers traced the origin of their low mathematics efficacy back to negative experiences they had while they were elementary students. This finding was noteworthy because it illuminated the existence of a relationship between a teacher's ability to negatively influence a student's immediate feelings as well as contribute to establishing lifelong low mathematics efficacy (Chapline & Newman, 1984; Wenta, 2000).

Gibson and Dembo

While Fennema and Sherman's FSMAS was one of the earlier tools designed to measure teacher mathematics efficacy, Gibson and Dembo (1984) later developed the most widely accepted reliable measure of general teacher efficacy at that time. The original measure had 30 questions that utilized a six-point Likert-scale response format ranging from strongly disagree to strongly agree. Question wording was positive in pertaining to competence and negatively toward tasks. For example, "I can reach a difficult student," and "Even if a teacher has excellent knowledge and skills, it has little influence on pupils' learning." This was the first successful attempt at creating an efficacy measurement tool that incorporated both Rotter's LOC model and Bandura's social cognitive theory.

Through its use and analysis, Gibson and Dembo identified two factors pertaining to the measurement of efficacy. First was *personal teaching efficacy* (PTE), which refers to self-efficacy, and second was *general teaching efficacy* (GTE), which refers to outcome expectancy. This dual structure was somewhat problematic in measuring efficacy efficiently because of the original 30 questions, 16 questions related to PTE and 14 to GTE. To be scored, the answers were added together to produce an overall score. This was problematic, as the score did not reflect PTE or GTE individually; rather it meshed them both together in a way that did not allow for the understanding of each factor in relation to efficacy development. Tschannen-Moran and Hoy (2001) addressed this issue when discussing Gibson and Dembo's, "lack of clarity about the meaning of the two factors and the instability of the factor structure make this instrument problematic for researchers" (p. 789).

Teachers' Sense of Efficacy Scale (TSES)

Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) attempted to design such a measure with their Teachers' Sense of Efficacy Scale (TSES). This 24-item test had a nine-point Likert-scale with responses ranging from nonexistent to excellent. It utilized three subscales that took into consideration the different aspects of efficacy within the classroom. They were efficacy for Instructional Strategies, efficacy for Classroom Management, and efficacy for Student Engagement. The TSES design measures efficacy broadly from teachers in pre-K through high school. Upon testing, practicing teachers enrolled in graduate studies made up the initial sample of 40% elementary teachers. The overall reliability found was .93. TSES data analyzed yielded understanding about novice teachers in comparison to veterans and the conclusion that gender and race are not related to self-efficacy in either category of educators (Tschannen-Moran & Woolfolk Hoy, 2001).

Efficacy is a complex construct; thus, the tools designed to measure efficacy must incorporate those complexities. Bandura (1997) wrote that a teacher's sense of efficacy might not be uniform across the tasks involved in teaching one specific subject as well as other subjects. Labone's (2004) research concluded the need for a deeper understanding about the kinds of context variables linked to teachers with a higher self-efficacy. Tschannen-Moran and Hoy (2001) concluded the need for more research to understand the relationship between experiences affecting teacher understanding of instruction and efficacy. Tschannen-Moran and Hoy (2007) also wrote about how understanding self-efficacy beliefs and behaviors in conjunction with environment can shape one another in what they termed reciprocal determinism, which could influence teacher efficacy.

All this taken into consideration poses the myriad of issues involved in accurately measuring efficacy. This is also reason to choose an instrument that focuses on measuring only mathematics efficacy instead of a general efficacy instrument because the teaching and learning of mathematics for students in the United States differs by state/region and is lagging behind that of their global peers (Corkin, Ekmekci & Papakonstantinou, 2015; TIMSS, 2011). Bandura (1997, 2001) recommended a tool that included measuring tasks at a variance of difficulties, thus allowing participants to quantify the strength of their efficacy beliefs in response to the varying degrees of difficulty to the task. Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) believed a valid measure needed to measure PTE and include an analysis of the task measured in relation to external factors surrounding the accomplishment of the task.

I used the adapted TSES for this study because it is, “superior to previous measures of teacher efficacy” (Woolfolk Hoy & Burke Spero, 2005, p. 354). Megan Tschannen-Moran from the College of William and Mary and Anita Woolfolk Hoy from Ohio State University created the TSES used in this research. Dr. Tschannen-Moran (Appendix A) granted permission to use, reproduce, and adapt to the survey to measure mathematics efficacy. The TSES incorporates Bandura’s theory of self-efficacy (1977, 1997) and Tschannen-Moran, Woolfolk Hoy, and Hoy’s Integrated Model of Teacher Efficacy (1998). The TSES contains three factors: Efficacy in Student Engagement, Efficacy in Instructional Practices, and Efficacy in Classroom Management, which were determined to be independent of one another through confirmatory factor analysis. Wolters and Daugherty (2007) examined the validity of the TSES, which showed a Cronbach’s Alpha coefficient above .80. The original tool consisted of 52 items, but after 3 separate studies, shortened into two shorter forms. The long form consists of 24 questions and short form consists of 12 questions. Both have the same three-factor structure of measuring

Efficacy in Student Engagement, Instructional Practices, and Classroom Management. Reliability analysis for internal consistency of the overall TSES long form was .94. For measuring Efficacy in Student Engagement, it was .87 and Efficacy in Instructional Strategies was .91. The TSES long form used in this study utilizes the same nine-point continuum ranging from 1 “Nothing,” 3 “Very Little,” 5 “Some Influence,” 7 “Quite a Bit,” and 9 “A Great Deal”, however, it included the word “mathematics” incorporated into each question in order to measure teacher mathematics efficacy.

The past 50 years have brought much understanding to the theory of efficacy and its measurement (Bandura, 1997). The various tools used to measure efficacy have led to a deeper understanding of measuring efficacy, which has led to the ability to measure efficacy as it relates to specific subject matter, such as mathematics.

Understanding Teacher Mathematics Efficacy

This section will describe what teacher mathematics efficacy is and how it is linked to self-efficacy and student achievement.

As previously noted, efficacy is a person’s belief in their own abilities to directly influence change in another (Bandura, 1977). I have also discussed how the idea of self-efficacy, though focused on one’s own ability to perform at a certain level, can still shape another person’s achievement (Tschannen-Moran et al., 1998). Yet in order to truly understand how teacher efficacy influences student achievement in mathematics, one must study how efficacy manifests itself in relation to mathematics (Clark et al., 2012; Jiang, Song, Lee & Bong, 2014; Nurlu, 2015; Snyder et al., 2011; Stevens et al., 2013).

Teacher Mathematics Efficacy

Efficacy in relation to mathematics, or mathematics efficacy, shapes how negatively or positively a person thinks about his/her own abilities in mathematics. The influence of mathematics efficacy in an elementary setting occurs daily as teachers attempt to instill deep content knowledge and understanding of foundational mathematics skills in their students and these students attempt to assimilate this learning into new knowledge (Boaler & Staples, 2008; Zuya et al., 2016).

Bandura's (1982) study of efficacy was the foundational study for other research focused on correlations between why teachers would avoid teaching mathematics and teacher confidence associated with mathematics curriculum (Boonen et al., 2014; Bracey, 2000; Brown, 2005; Jeffrey et al., 2018; Karp, 1991; McAnallen, 2010). The idea of confidence in relationship to curriculum stems from consistent findings of teachers demonstrating strong efficacy in mathematics when they identify themselves as enjoying the subject (Cunningham & Blakenship, 1979; Hone, 1970; Mechling, Stedman, & Donnelly, 1982). Also noted in research is the prevalence of elementary school teachers' avoidance of teaching mathematics as a likely result from low efficacy in mathematics (Max et al., 2014; Minor et al., 2015; Schoenberger & Russell, 1988).

Teacher Mathematics Efficacy and Student Achievement

It seems reasonable to assume an elementary teacher who enjoys their job and likes mathematics would exhibit high mathematics efficacy, but does this relate to student achievement? This is an important question as mathematics efficacy is a critical component in understanding student achievement in mathematics (Chang, 2015; Corkin et al., 2015; Jiang et al., 2014; Kaya & Bozdag, 2016; Nurlu, 2015; Pajares, 1996; Schunk, 1981; Swars et al., 2006;

Wenner, 2001; Wenta, 2000). When a teacher exhibits low mathematics efficacy, these beliefs have the potential to affect the quality, the focus, and the time devoted to mathematics instruction for students (Clark et al., 2012; Max et al., 2014; Minor et al., 2015; Riggs & Enoch, 1990; Wood, 1988). As noted by the NCTM standards, effective mathematics teachers must present, reason, and engage students in dialogue about mathematics if students are going to retain knowledge, understand concepts, and show increased performance on a variety of assessments (Hunt, 1985; Ma, 1999; Hembree, 1990; Prichard, 1995; Swetman, 1994).

It is important for teachers to understand the effects of low mathematics efficacy because of the negative influence on student perception towards mathematics and correlations between this and low student achievement (Isikoglu, Basturk & Karaca, 2009; Kaya et al., 2016; Swars et al., 2006). Teachers with low mathematics efficacy are more likely to foster mathematically anxious students (Swars et al., 2006; Zuya et al., 2016). These students are likely to show poor mathematics performance at all grade levels (Ma, 1999), avoid high paying careers that involve mathematics (Richardson & Suinn, 1972), develop lower self-esteem than their peers, and suffer from impaired performance (Ma, 1999; Suinn, Edie, Nicoletti & Spinelli, 1972).

Understanding the documented effects of high and low mathematics efficacy are important because once established, beliefs are much more resistant to change regardless of whether that person is in first grade or teaching first grade (Hoy & Spero, 2005). Thus, all teachers regardless of their level of mathematics efficacy may to continue acting within the confines of those mental constructs unless something intervenes (Bandura, 1977; Bandura, 1997; Battista, 1994; Zuya et al., 2016). Students are also heavily influenced to pursue or avoid mathematics by these same beliefs existing within their teacher at the expense of their learning and achievement now and in the future (Betz, 1978; Boaler & Staples, 2008; Brush, 1980).

These and other studies that have shown, “there is a strong reason to believe teachers’ beliefs and conceptions about mathematics and teaching mathematics play a vital role in their effectiveness as mediators between the subject and the learner” (Brown, 2005, p. 242). Student and teacher mathematics efficacy matters because self-efficacy is as strong of a predictor of student achievement in mathematics as ability in mathematics is a predictor of student achievement (Jiang et al., 2014; Kaya et al., 2016; Pajares, 1996).

Low mathematics efficacy is not a permanent condition and the above-mentioned negative influences have been shown to be reversible (Hembree, 1990); however, research suggests this is only true for those students who are able to spend time in a classroom with highly effective mathematics teachers holding high mathematics efficacy expectations and outcome expectations (Bandura, 1994). Therein lies the irony of the situation. In order to raise a teacher’s mathematics efficacy, the teacher must willingly engage in the practices and type of teaching they are most likely to avoid (Lesh et al., 2014; Perrin, 2012; Giordano, 1993; Maccini & Gagcon, 2002; Prichard, 1995). The NCTM’s vision and the practices of ambitious mathematics instruction have teachers supporting students as they solve rigorous problems. Teachers must engage students in dialogue that shows their thought process and connects ideas among peers, rather than exhibiting students giving correct answers and the teacher moving on to the next problem (Boston, 2012; Nurlu, 2017; Stein, Engle, Smith & Hughes, 2008). The tenets of the NCTM and ambitious mathematics instruction are in contrast to most traditional mathematics instruction because they require teachers to respond to student thinking in order to create dialogue and plan for expected and unexpected student responses. Boaler and Staples’ (2008) mixed methods study of poor urban California schools’ highly effective mathematics instruction found when students were immersed in conditions described above, in conjunction with rigorous mathematics curriculum; they outscored their peer group and students from more affluent schools. Other noted benefits for the 700 students from Boaler and Staples' (2008) study were the development of greater empathy for differing cultures and backgrounds, an increased enjoyment of mathematics, and a desire to pursue mathematics related careers.

Summary

In summary, mathematics efficacy is a factor influencing achievement for both teachers and students. Negatively for students as low mathematics efficacy influences poor mathematics performance, inhibits career choices, and negatively contributes to self-esteem; for teachers, it can lead to avoidance of instructional practices and contribute to the development of low mathematics efficacy in students. Not all researchers, however, agree with this summation as the theory of efficacy is widely accepted, but degrees of influence are disputed as described in the next section.

Differing Perspectives on Teacher Mathematics efficacy

This section will describe research that has been associated with increased student achievement without focusing on teacher mathematics efficacy.

It would seem that mathematics efficacy is a key construct to change within the elementary school classroom in order to influence student achievement in mathematics in any region of the United States; however not all research supports this. For example, Benson (1989) found the relationship between teacher mathematics efficacy and student performance was not significant when studying 219 university students in statistics classes. This may have occurred due to students in advanced mathematics classes being more likely to be majoring in a mathematics related field and therefore comfortable with mathematics and exhibiting higher mathematics efficacy (Clark et al., 2012).

Many researchers argue that professional development, teacher instructional habits, and rigorous curriculum will bring about the desired national changes as measured by TIMSS and NCTM (Carney et al., 2016; Giordano, 1993; Lesh et al., 2014; Maccini & Gagcon, 2002; Nurlu, 2017; Perrin, 2012; Prichard, 1995). The NCTM prepares national reports on the progress of student mathematics achievement, as well as giving feedback and direction to the nation's leaders and teachers on how to address the trends noted in their data (Swars et al., 2006). Many of these reforms directly influence textbook companies, professional development, and research studies because of the NCTM's political influence in the United States, as well as their continual affirmation of the teacher being the crucial factor in raising student achievement (Battista, 1994). The National Assessment of Educational Progress (NAEP) reports have cited staggering gaps between white students and minorities and male and female achievement in relation to mathematics degrees, self-efficacy in mathematics, and overall performance (McGraw et al., 2006; Aiken, 1976).[4] The RAND mathematics study group has also researched how minority students achieve in mathematics. Their conclusions have influenced many researchers as well and have consistently shown teacher mathematics efficacy to be strongly correlated to mathematics scores among minorities (Armor, Conroy-Oseguera, Cox, King, McDonnell, Pascal, Pauly & Zellman, 1976).

Though useful information, these reports offer limited perspective in how data were gathered and analyzed. Bandura's research on efficacy is the standard by which other methods are compared. Surprisingly, even Bandura warns against using student efficacy beliefs as a predictor of future academic achievement (Bandura, 1997). Accuracy is paramount in any research and when studying efficacy, the skewing of results may occur due to a lack of

[4] These results are similar to what is shown in Table 1

specificity and clarification of beliefs (Pajares, 1996). Many mathematics efficacy instruments have a general focus such as, "I like mathematics" which Bandura (1997) cautions against using. In order to understand the influence of mathematics efficacy on future achievement, better instruments will need to clarify these beliefs by focusing on specific domains such as, "Circle the number on the line that matches how sure you are that you could work problems like those shown and get the right answers" (Schunk, 1981). This research demonstrates the need to only use task-specific instruments and study efficacy as it relates to specific subject areas, such as mathematics, to get a clearer picture of its relationship with student achievement.

Another problem with these instruments is that many offer a series of redundant questions about a topic seeking to validate internal consistency rather than probing the parameters of efficacy (Pajares, 1996). As Pajares (1996) wrote, "If the purpose of a study is to achieve explanatory and predictive power, self-efficacy judgments should be consistent with and tailored to the domain of functioning and/or task under investigation" (p. 550).

The importance of utilizing mathematics efficacy data is dependent on how it is gathered. Thus, researchers must utilize mathematics efficacy tools that utilize self-assessment in conjunction with direct observation to link mathematics efficacy with outcome (Boston, 2012; Miller et al., 2017; Pajares, 1996). This may be a contributing factor in the division of parties as to how best to improve student achievement.

Focus on Teacher Actions

Other research suggests a focus on what teachers physically do in the classroom, rather than mathematics efficacy, to be the most efficient way to address student achievement in mathematics (Chang, 2015; McCaffrey, Lockwood, Koretz & Hamilton, 2003; Muis et al., 2013). McCaffrey, Lockwood, Koretz, and Hamilton's (2003) research using value-added models for teacher accountability confirmed that teachers influence student achievement. What was not clear from the research was the strength of the relationship an effective teacher has on improved student scores. Hendy, Schorschinsky, and Wade (2014) concur that teachers are a pivotal factor in student achievement but noted a lack of consensus in the literature on what is the most important factor of an effective teacher. There are inconsistent results related to how background characteristics of teachers correlate with student achievement (Klassen & Chiu, 2010; TIMSS, 2011; Wenta, 2000; Yavuz, Gunhan, Ersoy & Narli, 2013). Using the ECLS (Early Childhood Longitudinal Study) dataset, Palardy and Rumberger (2008), concluded that teacher demographics (such as degrees attained, intelligence, varying experiences, and other credentials), may be highly sought by school districts, but have very little evidence showing strong relationships with student achievement. In fact, Klassen and Chiu's (2010) research showed teacher experience to be non-linear in relation to teacher mathematics efficacy towards teaching strategies and student engagement. Their research showed that efficacy beliefs could change and fluctuate over time.

Focus on Professional Development

Professional development is likely to improve student achievement when it has a plan for longevity, homogeneity of teachers within the group, focused outcomes, and utilizes instructional materials already in use within the classroom (Borko, 2004; Carney et al., 2016; Clark et al., 2012; Nurlu, 2017; Stevens et al., 2013). Common goals for learning of specific concepts or standards in mathematics have accounted for improved student achievement in mathematics as well as improved teacher content knowledge (Clements & Sarama, 2004; Cobb & Jackson, 2011). This improved mathematics knowledge for teaching is associated with significant positive student outcomes when evaluating mathematics practices and student participation (Hill, Rowan & Ball, 2005). Likewise, errors and imprecision in teaching have been shown to be negatively correlated to student outcomes (Hill et al., 2005).

Boaler and Staples' (2008) study incorporated many of those aspects (professional development, teacher instructional habits, and rigorous curriculum) in their research through investigation of the need for more understanding of the various ways mathematics can be taught under a variety of conditions, such as geographical location, culture of schools, and student background. In their study, 10-20% more students in the control group scored at or above basic in the California Standards test compared to the rest of the study's population and 25% more students in the control group identified themselves as enjoying mathematics than the rest of the study's population. These teacher-identified changes stem from time each week spent planning individually and collectively beyond contractual time for designing rigorous problems with multiple paths to a correct answer.

Though the results of Boaler and Staples' (2008) study of student achievement seemed to be contrary to research concerning mathematics efficacy and student achievement, it is important to note that the study did not isolate mathematics efficacy as a variable of study. Though not directly stated, their work demonstrates the effectiveness that homogenous philosophies, extra time spent collaborating, and detailed work through creating curriculum extension activities are likely to shape teacher mathematics efficacy.

Summary

Understanding student achievement in mathematics is complicated. Teacher efficacy, by nature, consists of multiple external and internal influences occurring simultaneously. Thus, an elementary classroom houses a diversity of interactions dependent on an environment where students can achieve (Palardy & Rumberger, 2008; Schoenfeld, 2013; Schoenfeld, Floden & the

Algebra Teaching Study and Mathematics Assessment Project, 2014; Schunk, 1981; Smylie, 1988; Stein et al., 2008; Swars et al., 2006; Tosun, 2000; Trice & Ogden, 1986). The relationship between a teacher's belief in his or her ability to reach a goal and the affect it has on instruction, or teacher mathematics efficacy, correlates to both positively and negatively shape the relationship between a student and instruction, as measured by student achievement scores (Chang, 2015). This relationship is further complicated by the varying degrees of competency of the subject matter, comfort with the instructional techniques, and desire to teach or avoid the instruction, just to name a few. It stands to reason there being multiple variables affecting teacher mathematics efficacy and the influence of the instruction implemented across the diversity of that relationship.

There is strong evidence that mathematics efficacy is associated with student achievement, however there is room for clarification on the strength of the relationship between elementary teacher mathematics efficacy and student achievement. The results from Table 1 are indicative of a problem existing within public education on a national level for student mathematics achievement varies by student demographics and regionally.

In the current age of equity for all children, mathematics education must change in states, schools, and even within individual teachers' classrooms, so all children can acquire and demonstrate their knowledge in mathematics. The change needs to address two problems that are interrelated: (1) the hiring of teachers with low mathematics efficacy to instruct students in the foundational skills in mathematics; (2) student mathematics achievement varies widely by geographic location within the Midwest, Southern, and Eastern parts of the United States. Achievement varies so much that the vast majority of students in the highest performing mathematics state, per TIMSS (2011) data, are scoring higher in mathematics than all but the wealthiest students in the lowest achieving state.[5]

In order to understand how teacher action be disconnected from teacher knowledge, it is important to understand the theory of efficacy and its relationship with action. Bandura (1994) defined efficacy as a person's belief in his or her own abilities to directly influence change in another. Efficacy shapes action through effecting how persistent, resilient, and how much effort a teacher will expend in order to implement those strategies, develop student understanding, and ultimately positively influence student achievement (Tschannen-Moran et al., 1998). Based on available research on efficacy, it is likely that the higher the efficacy of a teacher, the more likely the teacher will have a raised level of desire and willingness to try the implementation of various strategies to improve student achievement even when faced with failure (Riggs & Enoch, 1990; Wenta, 2000).

In summary, students are unlikely to perform cognitive tasks beyond their abilities (Pajares, 1996). Beliefs are more like blueprints that we follow to attain a desired outcome rather than some mystical power compensating for knowledge or skills we do not already have. There are many known and unknown factors contributing positively and negatively to student achievement. Teacher efficacy positively correlates with student test scores; but more research is needed to fully understand the influence of elementary teacher mathematics efficacy on student achievement. What is lacking from the literature is a deeper understanding of the relationships between teacher demographics and level of mathematics efficacy.

In Chapter 3, I will detail how my study furthers the body of research by studying specific teacher variables that may shape mathematics efficacy. Other benefits of my study will

[5] Per data in Table 1

be utilizing the TSES to measure and deepen the understanding of teacher mathematics efficacy through investigating how specific teacher demographics influence mathematics efficacy in each subscale of the TSES.

CHAPTER 3: RESEARCH METHODS

Chapter 3 outlines how I examined the presence of any relationships between selected teacher demographics and teacher mathematics efficacy. The first section in this chapter is the research design, followed by a description of the sample. The next section describes the instrumentation used. The final sections describe the procedures used for data collection and data analysis. Finally, I conclude with the limitations of this study.

Research has shown there is a correlation between teacher efficacy in general and student achievement (Boonen et al., 2014; Hendy et al., 2014; Palardy & Rumberger, 2008; Tschannen-Moran et al., 1998). In part, I sought to add understanding to the body of research by investigating how varying demographics may contribute to teacher mathematics efficacy within elementary teachers. I attempted to do this by probing deeper into the specific factors affecting teacher mathematics efficacy (as defined by the adapted Teacher Sense of Efficacy Scale [TSES]).

Research has also revealed a correlation between elementary teacher mathematics efficacy and student achievement in mathematics based upon limited teacher demographic data (Ma, 1999; Swars et al., 2006). This study investigated associations between teacher demographics (such as, gender, years of experience, highest degree earned, race, grade level taught, and highest mathematics course taken in college) and teacher level of mathematics efficacy.

Purpose of the Study

The purpose of this study was to adapt the TSES to explore what teacher attributes relate to higher levels of mathematics efficacy in practicing elementary teachers. The dependent variables were mathematics efficacy scores of elementary teachers as measured by the adapted

Teachers' Sense of Efficacy Scale (TSES) and the three subscale mathematics efficacy scores (Student Engagement, Instructional Practices, and Classroom Management). The independent variables were teacher gender, experience, highest level of degree attained, race, grade level, and highest mathematics class taken in college.

Research Questions

The central research questions guiding this study include:

1. How does the Teacher Sense of Efficacy Scale (TSES) adapt and serve as a reliable measure of mathematics efficacy?
2. How does elementary teacher mathematics efficacy (as measured by the adapted TSES) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?
3. How do the subscales of the adapted TSES (Student Engagement, Instructional Strategies, and Classroom Management) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?

Research Design Rationale

This study followed a quantitative research design rooted in survey research. Creswell (2009) explained the value of quantitative research design is its ability to examine the relationship between multiple variables while, "building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings" (p. 4). Thus, the use of teacher survey responses explored the continuous variable of mathematics efficacy present in the differing teacher demographics.

Through the research questions, I sought to understand associations between teacher demographics across the continuous variable of mathematics efficacy. I sought to discover common patterns among teacher demographics, as well as understand the distinctions and differences if present. Recognizing and understanding any present patterns could be useful for future researchers in better understanding teacher curriculum implementation in how it relates to mathematics efficacy and provide strategies for improving student achievement within the mathematics efficacy construct. The data gathered represented 240 kindergarten-through-fourth grade elementary teachers in a large urban school district to best understand mathematics efficacy categories and most closely mimic the expected results within the district as a whole. Teacher mathematics efficacy and demographics were analyzed for relationships from their grade levels.

During the first phase of the study, quantitative data gathered through the adapted TSES survey tool were analyzed to understand the prevalence and presence of mathematics efficacy within the teacher sample. The second phase of the research involved correlating the data between teacher demographics and mathematics efficacy in order to discover the presence of any relationships.

Selection of Participants

Sample

The sample size consisted of nine elementary schools within a large urban district (See Table 2). The district served nearly 84,000 students in its elementary, middle, high, and alternative learning schools. Due to the district consisting of all schools within the same county, there was variance between individual schools as it related to poverty, ethnicity, and student achievement. The nine elementary buildings served both urban and suburban areas with mixed demographics of students in areas of socioeconomic status, race, and proficiency on state accountability tests in mathematics. The state accountability test utilized in Table 2 was administered in all elementary schools in the southern state of this study.

Table 2. *Description of Sample Elementary Schools and the District*

Name	Students	Economically Disadvantaged	Minority	State Assessment Mathematics Pass Rate
Elementary Sample	5,320	55.0%	67.2%	37.5%
District	84,000	50.6%	71.7%	29.2%

The elementary sample occurred in the same district and consisted of nine elementary schools serving close to 5,400 students in kindergarten through fourth grade. The schools served more students living below the poverty line than above it, was more ethnically diverse than white, and had less than half of the students scoring proficient or above proficient on the 2017-2018[6] state assessment in mathematics.

The district consisted of over 70 elementary schools, including traditional and non-traditional learning environments, and served over 84,000 students in a PreK-12 setting. The district served a high population of students living in poverty and the percentage of impoverished students was slightly higher within the sample. The district was very ethnically diverse with almost three out of four students identifying as non-white. While the average minority makeup of the sample was much less than this, two of the schools within the sample had more than 80% ethnic diversity. Achievement was much higher within the sample than the district with both demonstrating far below 50% proficiency in mathematics.

[6] At the time of this study, the 2017-2018 mathematics data were the most current data available.

Table 3. *Description of Elementary Schools within the Sample*

Name	Economically Disadvantaged	Ethnic Diversity	State Assessment Mathematics Pass Rate
Elementary A	40.0%	48.2%	63.1%
Elementary B	42.0%	43.0%	51.9%
Elementary C	90.0%	72.0%	31.0%
Elementary D	48.1%	41.3%	37.0%
Elementary E	37.2%	48.4%	56.6%
Elementary F	93.4%	88.1%	23.2%
Elementary G	95.1%	82.3%	17.6%
Elementary H	28.0%	25.1%	48.7%
Elementary I	51.5%	78.1%	37.5%

Table 3 shows the poverty rate, ethnic diversity, and achievement for each elementary within the sample. All schools served a student population that fell within the ranges of 28% to 95% living in poverty. The sample was also very ethnically diverse with a range of minority populations from 25% to 88%, however the majority of schools had a student body that was 40% or more ethnically diverse. The outlier in terms of poverty and ethnic diversity was Elementary H that was only 25.1% ethnically diverse and 28% economically disadvantaged with the next lowest ethnically diverse school being Elementary D with 41.3% ethnic diversity and Elementary E with 37.2% economically disadvantaged. Finally, the proficiency in mathematics in the sample fluctuated within the 17.6%–63.1% range of achievement. The outliers were Elementary F and G with 17.6% and 23.2% of students scoring proficient in mathematics. It is worth noting Elementary C, F, and G had the highest rates of economically disadvantaged students, most ethnically diverse populations, and the lowest achievement scores within the sample.

Electronic invitations to all kindergarten through fourth grade teachers in these buildings requested participation in this study through completing the TSES survey. The sample intended to represent the district, provide enough participants in order to clearly address the research questions, and reasonably generalize to the district.

Instrumentation

Teachers' Sense of Efficacy Scale (TSES)

As discussed in Chapter 2, an abundance of efficacy tools are available to researchers for analyzing general efficacy and subject specific efficacy in pre-graduate elementary teachers. This study required a tool specifically designed for practicing teachers with validity established for beginning and veteran elementary teachers in mathematics. The Teachers' Sense of Efficacy Scale (TSES) was adapted, with permission from the tool's authors[7], for use in this study through the addition of the word "mathematics" in order to measure teacher mathematics efficacy. This study was one of the few that has utilized the TSES to measure elementary mathematics efficacy (for example, see Charalambous, Philippou & Kyriakides, 2007).

The TSES tool used (see Appendix B) was a 24-question survey that assessed teacher comfort level with mathematics through questions such as, "I will continually find better ways to teach mathematics" and "I will generally teach mathematics ineffectively." The TSES tool was comprised of three subscales that measured teacher efficacy in Student Engagement (subscale 1), Instructional Practices (subscale 2), and Classroom Management (subscale 3). Demographic details added at the end of the survey-included years of experience, highest mathematics course taken in college, gender, highest level of degree, race, and grade level taught.

Teacher participants ranked each question on a Likert-scale of 1-9 with one indicating "Nothing" and nine indicating "A Great Deal". The results of Tschannen-Moran and Woolfolk Hoy's (2001) work showed three subscales with a Cronbach Alpha score of .94 (the Instruction

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[7] See appendix A

subscale had a Cronbach Alpha score of .91, the Engagement subscale had a Cronbach alpha score of .87, and the Behavior subscale had a Cronbach Alpha score of .90).

Procedure for Data Collection

Prior to the commencement of this study, the Institution Review Board was petitioned for research approval and permission obtained from school district administration prior to the distribution of the survey. Information collected included: data from teachers (teacher responses to the TSES survey [Appendix B]).

Confidentiality and Disaggregation

Collection of all direct response information came from licensed teachers. Participants were volunteers and their data remained confidential and referred to as Grade Level K, 1, 2, 3, or 4. The respondents in the study did not have their names or work assignments included in the study.

In order to disaggregate teacher responses with mathematics efficacy ratings, I asked participants to identify the grade level they taught to maintain confidentiality. Respondent groupings occurred by grade level taught as well as various teacher attributes. This allowed keeping participant information confidential from the school district, while at the same time being able to disaggregate demographic information within grade levels.

Data Collection

In order to collect information from the teachers, I applied for permission to solicit teachers through the sample district’s research and development survey board. After receiving permission, I then emailed a link and explanation about my study to the elementary principals within the sample. On an agreed upon date which varied by the different schools, all kindergarten, first, second, third, and fourth grade teachers were sent an electronic Qualtrics link that contained the informed consent letter and TSES survey tool from their elementary school principal. Teachers had three weeks to participate in the study with no reminders sent out. The approximate time for teacher participants to read the informed consent letter and complete the survey was 10 minutes.

Permission for using and adapting the TSES came from the survey designer (Appendix A) and placed in Qualtrics. Qualtrics is an electronic survey and data collection tool licensed for use through Ball State University. Standard directions for completing the survey were given prior to participation in the survey and a consent statement was required to be agreed to before administration of the survey could begin. Collection and organization of data from the TSES occurred through Qualtrics.

Descriptive and Inferential Analysis

For this study, the discrete variables were gender, highest level of degree attained, race, grade level taught, and highest mathematics course taken in college. I recorded frequencies for any discrete variables. Of these, gender and race were nominal variables and degree attained and highest course taken were ordinal variables. Teacher mathematics efficacy and teacher years of experience were continuous variables described by their mean and standard deviation. Teacher mathematics efficacy scores, as well as the subscale efficacy scores, were the dependent and key variables for the research questions as the adapted TSES allowed me to use 24 questions to generate one continuous overall efficacy score and three continuous efficacy scores for each subscale within a range of mathematics efficacy scores.

Research Question 1

For research question one, I ran confirmatory factor analysis on the adapted TSES survey results. I compared the alpha reliability score and factor loading results from my survey to those of Tschannen-Moran and Woolfolk Hoy (2001).

Research Question 2

In order to answer my second research question, I compared the dependent variable of mathematics efficacy score with the independent variables of gender, years of experience, race, highest degree attained, grade level taught, and highest level of mathematics course taken. When examining the relationship between teacher mathematics efficacy, gender, and race, I used a T-test. For examining experience and teacher mathematics efficacy, I used a Pearson Correlation. To determine the presence of a relationship between grade level taught, degree, mathematics class, and teacher mathematics efficacy, I ran an ANOVA test.

Research Question 3

For research question three, I used the dependent variables of each subscale mathematics efficacy score (Student Engagement, Instructional Practices, and Classroom Management). When examining the relationship between subscale teacher mathematics efficacy scores, gender, and race, I used a T-test. For examining experience and subscale teacher mathematics efficacy scores, I used a Pearson Correlation. To determine the presence of a relationship between grade level taught, degree, mathematics class, and subscale teacher mathematics efficacy scores, I ran an ANOVA test.

Summary

The purpose of this chapter was to detail the rationale for a quantitative design for this study to analyze elementary teacher demographic patterns based upon varying levels of teacher mathematics efficacy on the adapted TSES survey as well as on the three subscales embedded in the adapted TSES survey. Furthermore, it provided details on the collection, analysis, and storage of data. Chapter 4 will provide a detailed analysis of the results.

CHAPTER 4: RESULTS

In this chapter, I share the results of this study. First, I describe the sample used to obtain the results of this study, and then respond to each research question, starting with the reliability of the adapted TSES as a measure of mathematics efficacy. Then, I describe how elementary teacher mathematics efficacy (as measured by the TSES) differs in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college. Finally, I describe the results from how elementary teacher mathematics efficacy, as measured by the TSES subscales of Student Engagement, Instructional Practices, and Classroom Management, is associated with teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college.

Sample

This section will describe the nine elementary schools within a large, urban district in a southern state that participated in this study. Table 4 displays a summary of teacher participant demographic information as well as congruent national average data.

The maximum participation rate for this study was 346 teachers of which 240 teachers (69% of those surveyed) completed the TSES survey. Of those who participated 17.1% taught kindergarten, 21.7% taught first grade, 17.9% taught second grade, 15.4% taught third grade, and 27.9% taught fourth grade. Of those who participated, 96.2% were female. The sample had limited racial diversity with 6.7% of participants identifying as minorities. Finally, 45.0% attained a Master's degree, and 46.7% identified a mathematics for elementary teachers course as their highest mathematics class taken in college.

Table 4. *Descriptions of Teacher Participants (n = 240)*

Factor	Proportion of Sample (%)	National Averages[8] (%)
Grade Level Taught		NA
Kindergarten	17.1	
First Grade	21.7	
Second Grade	17.9	
Third Grade	15.4	
Fourth Grade	27.9	
Gender		
Male	3.8	10.5
Female	96.2	89.5
Race		
White	93.3	79.7
Non-White	6.7	20.3
Years of Experience		
0-3 Years	12.5	15.2
4-9 Years	38.9	22.9
10-14 Years	20.1	19.1
15+ Years	28.5	42.8
Highest Degree Earned		
Undergraduate	44.2	43.1
Masters	45.0	45.8
Advanced	10.8	9.4
Highest Mathematics Course Taken		NA
High School Mathematics	29.6	
Mathematics for Elementary Teachers	46.7	
Mathematics for Major/Minor	23.8	

Within the sample, 16 teachers (6.7%) identified as non-white, which was much lower than the national average of 20.3%. Teacher years of experience, as reported on the survey, ranged from, “less than one year” to forty-four years of experience. The sample was congruent with national averages for years of experience except in the 4-9 years category, which was higher than national average of 22.9% and 15+ years, which was lower than the national average of 42.8%. Highest degree earned results were evenly split between 44.2% indicating

[8] National averages were gathered from the 2015-2016 National Teacher and Principal Survey (NTPS) dataset (U.S. Census Bureau, 2016). At the time of writing this dissertation, 2015-2016 data was the most recently released data.

Undergraduate and 45% indicating Masters, but advanced degrees (Ed.S. or Doctorate) were far fewer with only 10.8%. Degrees earned per category within the sample were consistent with national averages. The reporting on the survey of highest mathematics course taken originally was nine categories, but after analyzing, the reduction of data to three categories was necessary to allow for optimally balanced and representative groupings of the collective sample. These categories were High School Mathematics for mathematics classes available in high school, Mathematics for Elementary Teachers, and advanced mathematics classes for Mathematics Major/Minor. Within the sample 29.6% indicated a high school level mathematics course, 46.7% cited a mathematics class specifically for elementary education majors, and 23.8% took an advanced mathematics course. These data were not available per the NTPS dataset; thus, I was unable to compare course-taking patterns with a nationally representative sample of teachers. The sample of teacher participants was balanced between grade levels taught with a majority of teacher participants teaching fourth grade (27.9%). Gender was imbalanced within the sample with the vast majority of teacher participants were female (96.2%). This pattern is similar to national demographic patterns showing more female than male teachers in the elementary school setting (Kober & Usher, 2012) however, females were overrepresented within the sample compared with national averages. Table 4 displays a more detailed description of the sample as well as a description of national averages.

Research Question 1

Confirmatory Factor Analysis

Teacher participants ranked each adapted TSES question on a Likert-scale of 1-9 with one indicating “Nothing” and nine indicating “A Great Deal”. The mean for each question was then summed to produce an overall mathematics efficacy mean (M = 7.04, SD = 0.84). The adapted TSES tool was comprised of three subscales that measured mathematics efficacy in relation to Student Engagement (subscale 1), Instructional Strategies (subscale 2), and Classroom Management (subscale 3). The results of Tschannen-Moran and Woolfolk Hoy's (2001) work showed three subscales with an overall Cronbach Alpha score of .94 (Instruction, Engagement, and Management had Cronbach Alpha scores of .91, .87, and .90 respectively). The TSES was adapted to measure mathematics efficacy for this study and was one of the few studies to use the TSES to measure mathematics efficacy. Through confirmatory factor analysis, the adapted TSES was confirmed to continue to have a reliable efficacy construct as well as the continued presence of the Instructional Strategies, Engagement, and Management subscales that explained 39% of the variance with an overall Cronbach Alpha score of .93 (instruction, engagement, and management had Cronbach Alpha scores of .84, .89, and .93 respectively). Table 5 displays the results of Tschannen-Moran and Woolfolk Hoy's results as well as the results from this survey in order to show alignment between use of the TSES to measure efficacy and mathematics efficacy. For the ease of interpretation and consistency with the work of Tschannen-Moran and Woolfolk Hoy (2001), the utilization of teacher mathematics efficacy mean scores rather than factor scores for all analyses was necessary. For a detailed comparison of the factor loadings for each question of this study alongside Tschannen-Moran and Woolfolk Hoy's (2001) work, see Appendix C.

Table 5. *Comparing Factor Analysis Results*

TSES and Subscales	Tschannen-Moran and Woolfolk Hoy's Reliability Scores	Current Study's Reliability Scores
TSES	0.94	0.93
Student Engagement	0.87	0.89
Instructional Practices	0.91	0.84
Classroom Management	0.90	0.93

Research Question 2

Research question two asked, "How does elementary teachers' mathematics efficacy (as measured by the adapted TSES) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?" In order to answer this question, I utilized mean scores for teachers' mathematics efficacy drawing upon the adapted Teachers' Sense of Efficacy Scale (TSES).

Table 6 provides more detail on specific teacher demographics and mathematics efficacy results. When examining the relationship between teacher mathematics efficacy, gender and race (minority or not) a T-test was utilized. A Pearson Correlation was used for examining years of experience and teacher mathematics efficacy. To discern the presence of a relationship between grade level taught, highest degree earned, highest mathematics class taken and teacher mathematics efficacy an ANOVA test was run[9]. After analyzing the results of these tests, a significant relationship occurred between teacher mathematics efficacy, gender, and degree. Specifically, male teachers reported higher levels of efficacy compared to female teachers (M = 7.59, SD = 0.50 and M = 7.02, SD = 0.84) respectively.[10] In addition, teacher mathematics efficacy scores were raised with each subsequent degree attained in all categories (Undergraduate M = 6.92, SD = 0.77 and Masters M = 7.09, SD = 0.83 and Advanced M = 7.36, SD = 0.84).

[9] Detailed ANOVA results for RQ1 can be found in Table 12 in Appendix D.
[10] This finding should be taken with some caution as males were very underrepresented in this study.

Table 6. *Descriptives of Demographics on Mathematics Efficacy (n = 240)*

Descriptives	*n*	*M* (*SD*)	Statistics[a]	P-Value
Gender			2.01	.045*
Male	9	7.59 (0.50)		
Female	231	7.02 (0.84)		
Experience	240	11.67 (8.72)	.079	.222
Degree			3.28	.039*
Undergraduate	106	6.92 (0.77)		
Masters	108	7.09 (0.83)		
Advanced	26	7.36 (0.84)		
Race			-.056	.955
White	224	7.04 (0.84)		
Non-White	16	7.05 (0.84)		
Grade Level Taught			1.71	.147
Kindergarten	41	6.91 (0.11)		
First	52	6.95 (0.93)		
Second	43	6.94 (0.78)		
Third	37	7.04 (0.74)		
Fourth	67	7.26 (0.78)		
Mathematics Class			1.48	.230
High School Mathematics	71	7.12 (0.91)		
Mathematics for Elementary Teachers	112	6.94 (0.84)		
Mathematics for Major/Minor	57	7.14 (0.72)		

[a]Gender and race are reported utilizing a T-test. Experience is reported utilizing the Pearson Correlation test. Grade level taught, highest degree, and highest mathematics class are reported utilizing an ANOVA test.
*$p < .05$

Research Question 3

Research question three asked, “How do the subscales of the adapted TSES (Student Engagement, Instructional Strategies, and Classroom Management) differ in relationship to teachers’ gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?” In order to answer this question, I utilized a composite mean score of teachers’ mathematics efficacy for each of the subscales of the adapted Teachers’ Sense of Efficacy Scale (TSES).

Tables 7, 8, and 9 provide more detail on specific teacher demographics and the results within each of the three mathematics efficacy subscales. A T-test was utilized when examining the relationship between teacher mathematics efficacy, gender and race for each subscale. For examining experience and teacher mathematics efficacy, per the subscales, a Pearson Correlation was used. To determine the presence of any relationship between grade level taught, highest degree earned, highest mathematics class taken and subscale teacher mathematics efficacy I used an ANOVA test[11].

Table 7 shows the detailed results of these tests as mathematics efficacy relates to subscale one Student Engagement. A significant relationship occurred between mathematics efficacy in relation to student engagement and the level of degree attained. It is worth noting the mathematics efficacy mean scores for participants rose with the completion of each degree starting with Undergraduate (M = 6.62, SD = 0.98) to Masters (M = 6.79, SD = 0.98) and ending with Advanced (M = 7.23, SD = 1.01). The Tukey was utilized as a Post Hoc test for understanding the significant relationship between teacher mathematics efficacy and degree, as measured by the Student Engagement subscale. It showed that within the grouping of highest degree earned, when comparing participants indicating an Advanced degree to participants with an Undergraduate degree, there was a significant relationship (p = 0.01) to teacher mathematics efficacy that was not due to chance. There was no significant relationship between teacher efficacy and participants with a Master's degree[12]. No other demographics were significant as measured by subscale one.

[11] Detailed ANOVA results for RQ2 can be found in Table 13 in Appendix D.
[12] Detailed Tukey testing results can be found in Appendix D Table 13.

Table 7. *Descriptives of Demographics on Subscale 1 Student Engagement (n = 240)*

Descriptives	*n*	*M* (*SD*)	Statistics	P-Value
Gender			1.10	.272
Male	9	7.12 (0.64)		
Female	231	6.75 (1.00)		
Experience	240	6.76 (0.99)	.016	.802
Degree			4.07	.018*
Undergraduate	106	6.62 (0.98)		
Masters	108	6.79 (0.98)		
Advanced	26	7.23 (1.01)		
Race			-.581	.562
White	224	6.75 (0.99)		
Non-White	16	6.90 (1.03)		
Grade Level Taught			.212	.932
Kindergarten	41	6.70 (1.10)		
First	52	6.73 (1.08)		
Second	43	6.81 (0.81)		
Third	37	6.68 (0.92)		
Fourth	67	6.83 (1.01)		
Mathematics Class			.695	.500
High School Mathematics	71	6.81 (1.11)		
Mathematics for Elementary Teachers	112	6.68 (0.95)		
Mathematics for Major/Minor	57	6.86 (0.93)		

$^{*}p < .05$

Table 8 shows the detailed results of the analysis of teacher demographics and mathematics efficacy as measured by subscale two Instructional Strategies. A significant relationship existed between mathematics efficacy in relation to instructional strategies and gender.[13] Per mathematics efficacy mean scores, male teachers (M = 7.70, SD = 0.37) in the study were more efficacious than females (M = 7.04, SD = 0.95). No other demographics were significant as measured by the subscale two.

[13] Due to an under representation of males in this study, this finding should be taken with caution.

Table 8. *Descriptives of Demographics on Subscale 2 Instructional Strategies (n = 240)*

Descriptives	*n*	*M* (*SD*)	Statistics	P-Value
Gender			2.07	.039*
Male	9	7.70 (0.37)		
Female	231	7.04 (0.95)		
Experience	240	7.06 (0.95)	.111	.085
Degree			2.59	.077
Undergraduate	106	6.94 (0.84)		
Masters	108	7.09 (0.98)		
Advanced	26	7.40 (0.95)		
Race			.184	.854
White	224	7.06 (0.95)		
Non-White	16	7.02 (0.99)		
Grade Level Taught			1.67	.157
Kindergarten	41	6.94 (1.07)		
First	52	6.87 (1.02)		
Second	43	7.04 (0.76)		
Third	37	7.06 (0.95)		
Fourth	67	7.29 (0.89)		
Mathematics Class			1.66	.191
High School Mathematics	71	7.18 (0.99)		
Mathematics for Elementary Teachers	112	6.94 (0.95)		
Mathematics for Major/Minor	57	7.15 (0.95)		

*p < .05

Table 9 shows the detailed results of these tests in relation to how teacher demographics are related to mathematics efficacy as measured by subscale three Classroom Management. A significant relationship occurred between mathematics efficacy as it relates to classroom management and grade level taught. It is worth noting the mean mathematics efficacy scores for participants rose in each grade level from kindergarten to fourth grade except for second grade, which had the lowest overall mathematics efficacy mean score. For the Classroom Management subscale, when investigating the relationship between mathematics efficacy and grade level taught there was a predictable and significant relationship ($p = .013$) between second grade and fourth grade teachers as measured by Tukey. No other demographics were significant as measured by the subscale three.

Table 9. *Descriptives of Demographics on Subscale 3 Classroom Management (n = 240)*

Descriptives	*n*	*M* (*SD*)	Statistics	P-Value
Gender			1.76	.079
Male	9	7.95 (0.90)		
Female	231	7.28 (1.12)		
Experience	240	7.31 (1.12)	.069	.286
Degree			1.16	.313
Undergraduate	106	7.18 (1.03)		
Masters	108	7.40 (1.13)		
Advanced	26	7.44 (1.38)		
Race			.209	.834
White	224	7.31 (1.14)		
Non-White	16	7.25 (0.79)		
Grade Level Taught			3.19	.014*
Kindergarten	41	7.09 (1.26)		
First	52	7.25 (1.11)		
Second	43	6.97 (1.26)		
Third	37	7.38 (0.87)		
Fourth	67	7.66 (0.98)		
Mathematics Class			.854	.427
High School Mathematics	71	7.38 (1.11)		
Mathematics for Elementary Teachers	112	7.21 (1.21)		
Mathematics for Major/Minor	57	7.42 (1.12)		

*$p < .05$

Summary

The purpose of this chapter was to detail the results of the quantitative study exploring the presence of relationships between teacher mathematics efficacy and various teacher attributes. Confirmatory factor analysis, T-tests, ANOVA tests, and Pearson Correlations assisted in understating mathematics efficacy as measured by the adapted TSES survey as well as the three subscales of within the TSES. When investigating research question two, a significant relationship existed between mathematics efficacy, gender, and degree attained. Specifically, male teachers reported higher levels of efficacacy compared to female teachers and efficacy rose with the attainment of each degree after undergraduate. When the subscales of the TSES were tested in research question three, significant relationships were found between mathematics efficacy, gender (Student Engagement subscale), degree (Instructional Strategies subscale), and years of experience (Classroom Management subscale). Chapter 5 will provide conclusions, limitations, and recommendations for future research of the results.

CHAPTER 5: CONCLUSIONS

In this chapter, I describe the major findings of this dissertation and connect my results to the existing body of literature. I then discuss the implications of my research for educational theory, policy, and practice. Also included in this chapter will be limitations of the study and recommendations for future research.

Major Findings

Research Question 1

Research question one asked, "How does the Teacher Sense of Efficacy Scale (TSES) adapt and serve as a reliable measure of mathematics efficacy?" I found the adapted TSES to be a reliable measure of mathematics efficacy and in alignment with Tschannen-Moran and Woolfolk Hoy's TSES (2001). Through confirmatory factor analysis, the adapted TSES was confirmed to have a reliable efficacy construct (Cronbach Alpha score of .93) as well as the presence of three subscales in comparison to Tschannen-Moran and Woolfolk Hoy's TSES with three subscales and an overall Cronbach Alpha score of .94. The Cronbach Alpha scores for the three subscales on the adapted TSES and original TSES were Instructional Strategies (.84 and .91), Student Engagement (.89 and .87), and Classroom Management (.93 and .90) which closely mirrored one another.

Research Question 2

Research question two asked, "How does elementary teachers' mathematics efficacy (as measured by the adapted TSES) differ in relationship to teachers' gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?" I found significant relationships between teacher mathematics efficacy, gender, and degree earned. Males reported a higher level of mathematics efficacy than females within the sample. Also noteworthy was the finding of a relationship between mathematics efficacy and degree earned. As the sample advanced in highest degree earned, so too did mathematics efficacy mean scores increase. I found no relationships between any of the other isolated teacher demographics and mathematics efficacy.

The research is clear there are a multitude of teacher demographics and characteristics related to teacher mathematics efficacy. Prior research has found mathematics efficacy was significant in relation to teacher gender (Clark et al., 2012; Klassen & Chiu, 2012). Female teachers reported lower levels of mathematics efficacy within the classroom as compared to male teachers; these findings are consistent with this dissertation. The vast majority of the study participants were female teachers; however, the nine males within the sample felt more efficacious than the 231 female teachers. It is interesting to note that Tschannen-Moran and Woolfolk Hoy (2001), in contrast to the findings of this study, reported gender not related to teacher efficacy as measured by the TSES. Finally, Clark, DePiper, Frank, Nishio, Campbell, Smith & Choi (2012) found that the attainment of a Master's degree in upper elementary teachers was significantly related to elevated levels of mathematics efficacy. Specifically, they found that elementary teachers with a Master's degree had a higher mathematics efficacy than those with an undergraduate degree. My findings support prior research done with elementary school teachers and show the importance of further understanding how gender and highest degree earned can shape mathematics efficacy.

While my study did not detect a relationship between teacher mathematics efficacy and race, other literature supports this finding (Clark et al., 2012; Klassen, Bong, Usher, Chong, Huan, Wong & Georgiou, 2009). While the sample in this study was a relatively homogenous teaching sample to a relatively diverse student body, teachers tend to have higher mathematics efficacy when their race/ethnicity is similar to the students they serve (Klassen et al., 2009). However, Tschannen-Moran and Woolfolk Hoy's (2001) study found race was not significantly associated with teacher efficacy. Also found to influence teacher mathematics efficacy are years of experience teaching (Chester & Beaudin, 1996; Klassen & Chiu, 2007). Teachers tend to be more efficacious as they acquire experience in the classroom setting even though my research was unable to detect this relationship. Another teacher demographic that can shape teacher mathematics efficacy are the undergraduate and graduate level mathematics courses taken by teachers (McAnallen, 2010). McAnallen found that more advanced mathematics courses taken in teacher preparatory programs correlated with higher levels of teacher mathematics efficacy. My research finding of no relationship between race, years of experience, grade level taught, highest mathematics class taken and mathematics efficacy is surprising because it is in contrast to previous research.

It is possible the lack of statistical relationships in this study are attributed to a small sample size[14] and limitation of focusing on teachers within one school district. Concentrating on a single district and nine elementary schools could have limited variation. By design, this study attempted to fully understand the variables influencing elementary teachers within an urban environment to the exclusion of suburban and rural communities. This design limited the understanding of what may be important variables within suburban and rural communities that shape teacher mathematics efficacy and could lead to a more inclusive understanding of the relationships between teacher demographics and mathematics efficacy (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998).

[14] While the sample of nine elementary schools was large enough to explore significant and reliable findings, it is very small when compared to the overall district of 73 elementary schools.

My findings for this question are best summarized by Wayne and Youngs in their research when they stated, “Teachers differ greatly in their effectiveness, but teachers with and without different qualifications differ only a little” (2003, p. 108). Nonetheless, it is important to not abandon this work but continue understanding predictors of teachers’ mathematics efficacy within a larger more inclusive context to allow for more precision in understanding how gender and degrees earned contribute to teacher mathematics efficacy and if there are other important teacher demographics that contribute to mathematics efficacy.

Research Question 3

Research question three asked, “How do the subscales of the adapted TSES (Student Engagement, Instructional Strategies, and Classroom Management) differ in relationship to teachers’ gender, years of experience, highest level of degree, race, grade level, and highest mathematics class taken in college?” The results showed similarities between the results with question one as well as some important differences. Just like in research question one, gender and degree earned were significant with teacher mathematics efficacy, however degree was only significant on subscale one student engagement and gender only on subscale two instructional practices. Grade level taught, which was not found to be significant in question one, was significant on subscale three Classroom Management.

In this dissertation, there were significant relationships between teacher mathematics efficacy, gender, degree, and grade level taught and none between teacher race, highest mathematics class and teacher mathematics efficacy as measured by the three subscales of the adapted TSES. When analyzing gender differences, the males in this study reported higher levels of mathematics efficacy, were more likely to have a Master’s or advanced degree, were more likely to teach a higher grade, and were more likely to have majored/minored in mathematics than the female participants. Table 10 shows a detailed comparison of gender concerning mathematics efficacy, degree, experience, grade level taught, and highest mathematics class taken.

Table 10. *Gender Descriptives (n = 240)*

Descriptives	*Male (n=9)*	*Female (n=231)*
Efficacy Mean Score	7.59 (0.50)	7.02 (0.84)
Degree[a]		
Undergraduate	22.0	45.0
Masters	67.0	44.1
Advanced	11.0	10.8
Experience Mean	9.2	11.2
Grade Level Taught[a]		
Kindergarten	0	17.7
First	11.0	22.0
Second	0	18.6
Third	0	16.0
Fourth	89.0	25.5
Mathematics Class[a]		
High School Mathematics	33.0	22.9
Mathematics for Elementary Teachers	22.0	47.6
Mathematics for Major/Minor	44.0	29.4

[a] Degree, Grade Level Taught, and Mathematics Class are reported by percentage of the gender sample belonging to each category

One reason gender may have had a significant relationship to mathematics efficacy as measured by the Instructional Strategies subscale is because the males in this study were more likely to have majored or minored in mathematics in college and attained a Master's or advanced degree. Exposure to advanced mathematics classes could raise mastery experiences with mathematics concepts prior to entering the classroom as a teacher (Jeffrey, Hobson, Conoyer, Miller & Leach, 2018). That background could be related to the frequency of implementing alternative mathematics strategies within the classroom, using a variety of assessment strategies, and providing alternative explanations when students are confused (McAnallen, 2010). It is also more likely that males, as compared to females, in advanced mathematics classes are encouraged by professors or classmates (Jeffrey et al., 2018). This verbal persuasion could result in a raised capability in responding to difficult mathematics questions from students within the classroom. This training may also result in positive vicarious experiences increasing the desire to construct high quality mathematics questions and prepare appropriate mathematical challenges for students (Miller, Ramire & Murdock, 2017).

Also noteworthy was the finding of a relationship between mathematics efficacy and degrees earned. Within the sample, the more advanced the degree earned equated to a higher mathematics efficacy mean score as measured by the student engagement subscale. One reason for this could be due to related mastery experiences from classwork and research involved in graduate school (Jeffrey et al., 2018). These mastery experiences could help in the development of advanced teaching strategies and assist students in thinking critically and learning to value mathematics (Clark et al., 2012). This training could provide exposure to verbal persuasion from networking with other teachers in graduate work that may be associated with the effectiveness of motivating students and developing their mathematics efficacy (Miller et al., 2017). Another reason for this finding could be due to teacher experience. While years of experience was not significant with mathematics efficacy in this study, teachers with advanced degrees are more likely to have taught longer than those who have an undergraduate degree. The mean years of experience for participants with an Undergraduate degree was eight years, Master's degree was 13 years, and Advanced degree was 16 years. In investigating this further through regression tests, degree earned and years of experience were not significant to teacher mathematics efficacy.[15]

[15] Neither years of experience (p = 0.42) nor highest degree earned (p = 0.07) were significant through various regression tests.

Another finding was mean scores for grade level taught were raised in each subsequent grade level except for second grade as measured by the Classroom Management subscale. Second grade teachers exhibited the lowest mathematics efficacy scores out of all the grade levels. One reason why mathematics efficacy could have raised alongside the age of students per the Classroom Management subscale could be due to the increasing maturity level of students. As students become older, they are less likely to need constant physical breaks, be less easily distracted, and need less foundational skills to function independently within the classroom (Clark et al., 2012). A reason why second grade teachers exhibited the lowest mathematics efficacy could be due to it being the first year of district implementation of NWEA MAP assessments utilized for tracking purposes. Low mathematics efficacy can result in low mathematics efficacy expectations (Bandura, 1997). This testing creates the first high stakes environment students experience in school and an environment where second grade teachers could feel judged (Fitchett & Heafner, 2012). This may have negatively influenced teacher mathematics efficacy and efficacy expectations for students, which may have resulted in second grade teachers having the lowest efficacy scores in the sample.

Limitations of the Study

Sample Size

A major limitation of this study was the sample size. Despite intending to represent an entire district of over 2,800 elementary teachers and 73 schools, due to district constraints on the size of the study, only 240 teacher participants from nine elementary schools were included. While the 240 respondents had representation from every school and grade level within the sample, due to the vast geographical area of the district, many of the nuances within the district remained not captured. The small sample participation fell short of representing the rural and suburban elementary schools contained within the sample school district.

Implications and Directions for Future Research

This section will describe the implications of my findings as they relate to decisions made by local schools, school districts as a whole, and university teacher preparatory programs.

At the time of this study, there was a lack of extensive research on teacher mathematics efficacy within the elementary school setting utilizing the TSES. The findings in this study begin to outline the importance of understanding teacher mathematics efficacy within elementary schools and the variables shaping mathematics efficacy.

It is of practical importance to study elementary teacher mathematics efficacy on a much larger scale to understand how different teacher and building effects shape elementary teacher mathematics efficacy. After analyzing the data within the context of the subscales of the adapted TSES and relationships with school level demographics, gender, degree, and grade level taught were significant. Male teachers within an elementary building, teachers with advanced degrees, and the higher the grade level taught, excluding second grade, all equated to exhibiting higher mathematics efficacy per the overall adapted TSES or one of the three subscales. Future research should focus on obtaining a sample with an over sampling of male candidate in order to further understand the association between efficacy and male elementary teachers. With male teachers less common in elementary schools, what are the implications of this finding for the onboarding teacher practices of districts and elementary principals? Districts and schools need to find ways to effectively recruit and retain male candidates in elementary classrooms (Brookhart & Loadman, 1996). It is also important that male teachers in elementary settings receive placements and support in teaching lower elementary grade levels (Stroud, Smith, Ealy

& Hurst, 2006). When thinking about teacher degrees earned, what are the effective strategies for school leaders when designing highly efficacious grade level teams? Districts need to collaborate with universities to create affordable graduate degree programs that include exposure to advanced mathematics classes for the purposes of increasing frequency of verbal persuasion for teachers (Jeffrey et al., 2018). University leaders also need to create elementary education programs that develop mastery experiences of practicing teachers through networking opportunities and sharing strategies (Miller et al., 2017). Also needed would be mathematics courses for preservice teachers that would increase opportunities for self-evaluation in understanding of mathematics content for the purpose of creating more positive vicarious and mastery experiences for teachers prior to their first classroom experience (Jeffrey et al., 2018). How can leaders account for the influence teacher gender, degree earned, and grade level taught can have on teaming dynamics, team culture, and building culture? Elementary principals need to shape physiological arousal associated with teaching mathematics through effective feedback and hiring practices that target males and teachers with advanced degrees (Brookhart et al., 1996).

The lack of findings between mathematics efficacy, race, years of experience, and highest mathematics class taken are of theoretical importance and could result from inadequate or poorly focused school supports. For example, Chester and Beaudin’s (1996) research found that self-efficacy beliefs correlate with established vicarious experiences such as mentoring programs and verbal persuasion occurring during vertical planning opportunities amongst teachers. Tschannen-Moran and Hoy’s (2007) work also corroborated self-efficacy amongst novice teachers being more susceptible to mastery experiences, verbal persuasion through feedback in post conferences, and working with an instructional coach. Large-scale professional development is effective in shaping content knowledge and instructional practices that positively shape physiological arousal in many teachers at the same time (Carney, Brendefur, Theide, Hughes & Sutton, 2016). Effective professional development could influence elementary teachers and schools to be more likely to show higher resolve with students, be inclusive of new methods, and take responsibility for student success (Nurlu, 2017). Through increasing teacher mathematics efficacy, school leaders are more able to control school supports in a way that influence and control for future mathematics achievement on high stakes tests (Chang, 2015). The findings of this study, while limited, still show the need for new research focusing on elementary teacher mathematics efficacy.

This study was conducted within a large economically disadvantaged urban district in a southern state. There can be the perception amongst educators that urban settings have more prevalent challenges influencing student achievement (Boaler & Staples, 2008; Borko, 2004; Maccini & Gagcon, 2002); it would be beneficial to compare these results with a diversity of other school settings such as affluent districts, rural districts, and suburban districts. Research supports the influence of demographics such as gender, degree earned, and grade level taught have on mathematics efficacy, but what are the significant variables within those different settings (Clark et al., 2012; Chester et al., 1996; McAnallen, 2010)? Research focused on these questions would provide a more detailed understanding of elementary teacher mathematics efficacy in a variety of school environments.

Future research is also needed to understand how school climate and culture shape elementary teacher mathematics efficacy. The teacher demographics isolated in this study targeted individual factors but did not examine variables such as teacher team environments, school wide foci, mathematics departmentalization, and teacher self-efficacy which all could be important factors shaping mathematics efficacy amongst elementary teachers. Healthy teaming environments can influence mathematics efficacy, as educators on teams are likely to increase the amount of time spent together conversing about and planning for instruction. Conversations occurring in that type of supportive environment can provide opportunities for verbal persuasion of novice and tenured teachers as they collectively assess and account for their teaching capabilities. Teacher teams can also provide a safe environment for teachers to collectively explore and influence physiological arousal to subject content and specific lessons. Effective school wide foci can lead to the implementation of opportunities to increase teacher mastery experiences through modeling and collective exploration of supports such as vertical planning and vicarious experiences. If future researchers can understand which demographics most greatly contribute to raised individual elementary teacher mathematics efficacy, then school leaders and teacher educators will need to provide professional development supports that lead to increased mathematics achievement in elementary schools (Carney et al., 2016). This information would also be useful to policy makers as they assign support through funding to different types of schools and school programming. How can money be directly linked with increased teacher efficacy in mathematics? What teacher and school effects are most subject to change with the investment of capital and therefore be related to teacher mathematics efficacy?

Summary

The central focus of this study was to investigate the factors contributing to the development of elementary teacher mathematics efficacy as measured by the adapted TSES. This topic is important because research shows efficacy shapes decision-making, mathematics efficacy shapes teacher instruction, and teacher instruction shapes student achievement. While there is much research on preservice level, high school level, and middle school teacher mathematics efficacy, there are few studies concerning elementary teacher mathematics efficacy. While my study was limited in its ability to find many relationships between teacher demographics and mathematics efficacy in an elementary setting that may not be the case for other researchers with a larger sample size set in a variety of contexts. This study has demonstrated there is a need for more research in understanding elementary mathematics efficacy; specifically, we need to know more about the relationship between gender, degree earned, grade level taught and mathematics efficacy. If future research confirms teacher gender, degree earned, and grade level taught are important factors affecting mathematics efficacy, then the onboarding practices and teacher supports of school leaders, undergraduate program recruitment practices, and allocation of federal education dollars may need to change in order to best enhance student achievement.

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APPENDIX A

William & Mary
School of Education

MEGAN TSCHANNEN-MORAN, PHD
PROFESSOR OF EDUCATIONAL LEADERSHIP

October 18, 2017

Nathan,

You have my permission to modify and use the Teacher Sense of Efficacy Scale (formerly called the Ohio State Teacher Sense of Efficacy Scale), which I developed with Anita Woolfolk Hoy, in your research. You can find a copy of the measure and scoring directions on my web site at http://wmpeople.wm.edu/site/page/mxtsch . Please use the following as the proper citation:

Tschannen-Moran, M & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*, 783-805.

I will also attach directions you can follow to access my password protected web site, where you can find the supporting references for this measure as well as other articles I have written on this and related topics.

I would love to receive a brief summary of your results.

All the best,

Megan Tschannen-Moran
The College of William and Mary
School of Education

P.O. Box 8795 • Williamsburg, VA 23187-8795 • (757) 221-2187 • mxtsch@wm.edu

APPENDIX B

Teacher Sense of Efficacy Scale (TSES)*

Developed by Megan Tschannen-Moran and Anita Woolfolk Hoy, used with permission,

adapted by Nate Miley through the insertion of the word "mathematics"

Directions: This questionnaire is designed to help me gain a better understanding of the kinds of things that create difficulties for elementary teachers in teaching mathematics. Please indicate your opinion about each of the statements below. Your answers are confidential.

	Nothing	**Very Little**	**Some Influence**	**Quite A Bit**	**A Great Deal**
1- How much can you do to get through to the most difficult students in mathematics?	1 2	3 4	5 6	7 8	9
2- How much can you do to help your students think critically about mathematics?	1 2	3 4	5 6	7 8	9
3- How much can you do to motivate students who show low interest in mathematics work?	1 2	3 4	5 6	7 8	9
4- How much can you do to get students to believe they can do well in mathematics?	1 2	3 4	5 6	7 8	9
5- How much can you do to help your students value learning in mathematics?	1 2	3 4	5 6	7 8	9
6- How much can you do to improve the mathematics understanding of a student who is failing?	1 2	3 4	5 6	7 8	9
7- How much can you do to foster student creativity in mathematics?	1 2	3 4	5 6	7 8	9
8-How much can you assist families in helping their children do well in mathematics?	1 2	3 4	5 6	7 8	9
9-How well can you respond to difficult mathematics questions from your students?	1 2	3 4	5 6	7 8	9
10- To what extent can you craft good mathematics questions for your students?	1 2	3 4	5 6	7 8	9
11- How much can you do to adjust your mathematics lessons to the proper level for individual students?	1 2	3 4	5 6	7 8	9

	Nothing	Very Little	Some Influence	Quite A Bit	A Great Deal
12- How much can you use a variety of assessment strategies in mathematics?	1 2	3 4	5 6	7 8	9
13- To what extent do you believe students' achievement in mathematics to be directly related to their teacher's effectiveness in mathematics teaching?	1 2	3 4	5 6	7 8	9
14- To what extent can you provide an alternative explanation or example when students are confused in mathematics?	1 2	3 4	5 6	7 8	9
15- How well can you implement alternative mathematics strategies in your classroom?	1 2	3 4	5 6	7 8	9
16- How well can you provide appropriate mathematics challenges for very capable students?	1 2	3 4	5 6	7 8	9
17- How much can you do to control disruptive behavior in the classroom during mathematics instruction?	1 2	3 4	5 6	7 8	9
18- How much can you do to get children to follow classroom rules during mathematics instruction?	1 2	3 4	5 6	7 8	9
19- How much can you do to calm a student who is disruptive or noisy during mathematics instruction?	1 2	3 4	5 6	7 8	9
20- How well can you establish a classroom management system with each group of students during mathematics instruction?	1 2	3 4	5 6	7 8	9
21- How well can you keep a few problem students from ruining an entire mathematics lesson?	1 2	3 4	5 6	7 8	9
22- How well can you respond to defiant students during mathematics instruction?	1 2	3 4	5 6	7 8	9
23- To what extent can you make your expectations clear about student behavior during mathematics instruction?	1 2	3 4	5 6	7 8	9
24- How well can you establish routines to keep activities running smoothly during mathematics instruction?	1 2	3 4	5 6	7 8	9

25. Grade Level Taught: ____________________

26. Race (select one): White Black or African American

    American Indian or Alaska Native Asian

    Native Hawaiian or Other Pacific Islander Hispanic or Latino

    Other

27. Gender (select one): Male Female

28. Years of Experience: ______________

29. Highest Mathematics Course taken (select one):

    Developmental Math Remedial Math College Algebra Pre-calculus

    Calculus/Analytic Geometry Math for Elementary teachers Statistics

    Accounting Advanced College Math for Math Major/Minor

30. Highest Level of Degree Earned (select one):

    Undergraduate Masters Ed.S Doctorate

My return of this survey implies my consent to participate in this research and I have been given a second copy of this form to keep for my records.

APPENDIX C

Table 11. *Comparison of Factor Loadings for the TSES*

TSES Factor Loadings	Tschannen-Moran and Woolfolk Hoy	Current Study
Instructional Strategies		
How well can you implement alternative mathematics strategies in your classroom?	.66	.71
To what extent can you craft good mathematics questions for your students?	.68	.65
How much can you do to adjust your mathematics lessons to the proper level for individual students?	.59	.64
To what extent can you provide an alternative explanation or example when students are confused in mathematics?	.70	.60
How much can you use a variety of assessment strategies in mathematics?	.72	.58
How well can you provide appropriate mathematics challenges for very capable students?	.55	.57
How well can you respond to difficult mathematics questions from your students?	.66	.55
To what extent do you believe students' achievement in mathematics to be directly related to their teacher's effectiveness in mathematics teaching?	.57	.37
Student Engagement		
How much can you do to improve the mathematics understanding of a student who is failing?	.57	.66
How much can you do to motivate students who show low interest in mathematics work?	.66	.65
How much can you do to help your students think critically about mathematics?	.56	.63

TSES Factor Loadings	Tschannen-Moran and Woolfolk Hoy	Current Study
How much can you do to get students to believe they can do well in mathematics?	.75	.62
How much can you do to get through to the most difficult students in mathematics?	.47	.61
How much can you do to help your students value learning in mathematics?	.70	.61
How much can you do to foster student creativity in mathematics?	.50	.58
How much can you assist families in helping their children do well in mathematics?	.63	.55
Classroom Management		
How well can you establish a classroom management system with each group of students during mathematics instruction?	.66	.70
How well can you respond to defiant students during mathematics instruction?	.61	.68
How much can you do to control disruptive behavior in the classroom during mathematics instruction?	.78	.67
How much can you do to get children to follow classroom rules during mathematics instruction?	.69	.67
How much can you do to calm a student who is disruptive or noisy during mathematics instruction?	.66	.67
How well can you keep a few problem students from ruining an entire mathematics lesson?	.62	.65
How well can you establish routines to keep activities running smoothly during mathematics instruction?	.50	.62
To what extent can you make your expectations clear about student behavior during mathematics instruction?	.53	.56

APPENDIX D

Table 12. *ANOVA Tables for RQ1*

Predictors	Sum of Squares	*df*	Mean Square	F	*p*
Grade Level Taught	4.79	4	1.20	1.71	.147
Degree	4.55	2	2.27	3.28	.039*
Highest Math Class	2.08	2	1.04	1.48	.230

*p < .05

Table 13. *Tukey Test ANOVA Tables for RQ3 by Subscale*

Predictors	Sum of Squares	*df*	Mean Square	F	*p*
Student Engagement					
Degree	7.91	2	3.95	4.07	.018*
Grade Level Taught	.853	4	.213	.212	.932
Highest Math Class	1.38	2	.693	.695	.500
Instructional Strategies					
Degree	4.65	2	2.32	2.59	.077
Grade Level Taught	6.00	4	1.50	1.67	.157
Highest Math Class	3.00	2	1.50	1.66	.191
Classroom Management					
Degree	2.95	2	1.47	1.16	.313
Grade Level Taught	15.63	4	3.90	3.19	.014*
Highest Math Class	2.16	2	1.08	.854	.427

*p < .05